SD11
A5A3
1940

Comp. 0.721

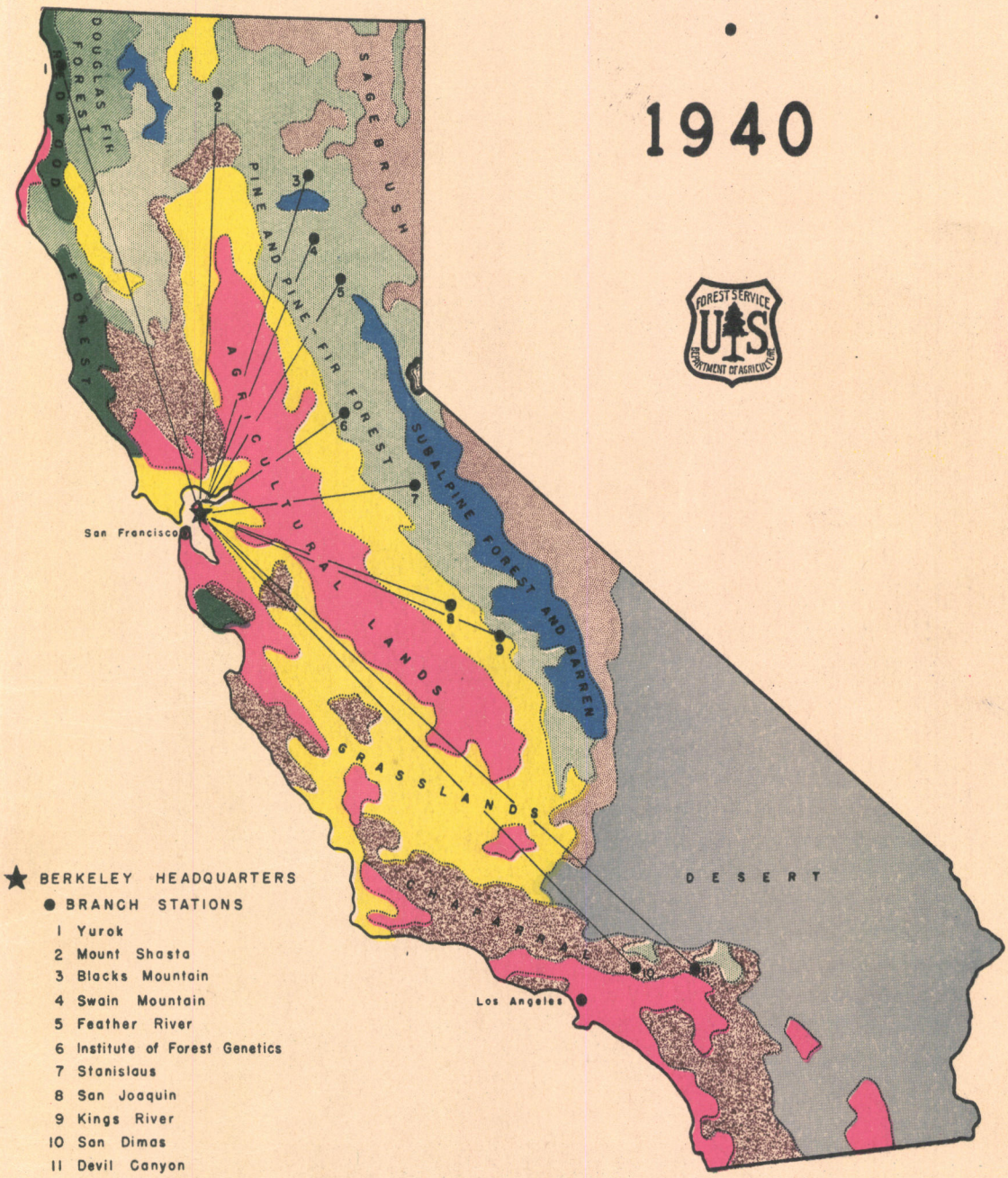
· ANNUAL REPORT ·

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

E. I. Kotok, Director — Berkeley, California

·

1940



Vegetation Type Map by Forest Survey Division.

LIBRARY COPY
ROCKY MT. FOREST & RANGE
EXPERIMENT STATION

Contents

Page

Director's General Report

Introduction 1

Forest Management

Pine Region 3
Redwood Region 11
Forest Fire Protection 15
Forest Genetics 19

Range Management 24

Forest Products 30

Forest Survey 33

Forest Economics 37

Forest and Range Influences 42

Interagency Flood Control Surveys 47

Library and Statistical Section 49

Cooperating Agencies 50

Publications 57

Project Status Sheets 61

R-CAL
RESEARCH PROGRAM

January 1941

ANNUAL REPORT OF THE

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

1940

DIRECTOR'S INTRODUCTION

New significance has attached to research during the year just ended. We have been subjected to two opposing influences. From one point of view attention has been diverted to some extent away from forest and range research as a direct result of the mounting interest — and justly so — in the defense program of the Nation. From another angle the need for research findings has increased.

Looking ahead and attempting to appraise the meaning of fast-moving events one fact stands out: research faces new and increased responsibilities. This seems inevitable whether the new emergency period is short or long and whether or not experimental facilities are proportionately increased. From the outlook ahead, we face three distinct kinds of responsibilities.

During the emergency period proper the clear responsibility of research is, of course, to supply all possible data that may bear directly or indirectly on defense. Questions of immediate urgency relating to most efficient production, delivery, and use of forest and range crops may reasonably be expected to exhaust available research data and to overtax existing experimental facilities in any attempt to obtain additional information in time to fill the need. The flood-control program strikingly illustrates both an especially important use of research data and our inability to meet demands fully. In the attempt, for example, to further safeguard the Los Angeles area (which incidentally is a production center for numerous national-defense items) a $1,400,000 action program relating to flood control will soon be launched. The "blueprint" for this big program is a comprehensive survey plan which includes important contributions of basic erosion and stream-flow data from the Influences Division, more particularly from the San Dimas Experimental Forest. Similar contributions to flood-control plans and programs for other watersheds have been made by other Divisions, especially Fire and Range. However, the available factual data have been woefully short of the demand. Nevertheless, to the limit of its facilities, research has the definite responsibility of meeting this need.

How to safeguard the basic land resource reasonably while production is geared to an emergency tempo presents an even greater challenge. It seems to me that research should assume a leading role, particularly on the national forests, in a definite attempt to avoid, or at least to minimize, some of the costly land-use mistakes of the first World War. Examples are: wasteful cutting of high-grade timber and nearly Western-wide overstocking of range lands — the injurious effects of which have not yet been fully overcome after the lapse of nearly a quarter century. The job here is to lessen the impact of inevitable war-period action. This challenge of leadership, in striking the best possible balance between conservative harvesting of timber and forage crops and the defense needs for these crops, falls most heavily on the Divisions of Range and Forest Management; to a varying degree on the others.

And finally it is my conviction that research must be looking ahead to the time when the critical defense period will have passed. Then the task will be primarily one of guiding the repair of locally damaged forest and range resources, of revitalizing disrupted projects, and of reorienting fact-finding programs to fit the changed post-war conditions. This task will involve every division and branch. In attempting to anticipate the nature of this task we as foresters have a special function, as the President has well stated. We must build up a backlog of useful work which will absorb some of industry's unemployment after the war, and which will also add to the permanent wealth of land.

It goes without saying that to meet these obligations even reasonably well will entail the closest cooperation and coordination of our work with that of administration and all the numerous other agencies with which we have been working on studies of land-resource management.

This 1940 annual report, in much the same fashion as last year's, reflects a variety of viewpoints, Division by Division, not solely the ideas of the Director. The past year's problems and progress are high-lighted in the following pages. Against this background the attempt has been to emphasize some of the more significant findings, particularly as they may affect the tasks that lie ahead.

FOREST MANAGEMENT

PINE REGION

Research in forest management in the pine region of California was restricted in 1940 to five groups of closely related studies: (1) Harvest conversion cuttings in old growth stands, (2) improvement cuttings in young stands on restocking cut-over lands, (3) methods of forest regeneration where reproduction has failed, (4) silvical studies, and (5) mensuration.

Results, 1940

Harvest cuttings

Ponderosa pine, Blacks Mountain. - The preliminary light insect-control cutting in the Blacks Mountain Experimental Forest was extended by 672 acres, making 1,748 acres from which the trees rated highly susceptible to insects have been removed in the last four seasons. The annual loss surveys, conducted by the Bureau of Entomology and Plant Quarantine, indicate that loss reductions have been 94, 88, and 82 percent, respectively, for areas treated 1, 2, and 3 years ago. Losses in virgin timber of 63 board feet to the acre in 1938, 102 board feet in 1939, and about 135 board feet in 1940 indicate a strong upswing in the insect cycle that should provide a crucial test of the effectiveness of treatment.

A mill recovery study was completed under direction of the Division of Forest Products for the first small sample of trees of the four insect risk classes. The results show that in this sample of 83 trees the trees of higher risk were less valuable than those of lower risk. These results suggest the possibility that economic selection and insect control are not entirely compatible. Several more of these small annual studies must be carried through, as proposed, before the results may be considered convincing.

Production and cost records for labor and equipment were maintained during the season for the cut of 2,437 M board feet and for five different methods of cutting. Considerable interest has been expressed in comparisons of costs for these different cutting methods. Such comparisons as can be made now are inconclusive because the principal factors determining differences in costs have not yet become effective. Enough time must elapse for the insects to pass the peak of their cycle and for a larger area to be logged before conclusions can be drawn as to the degree and period of control afforded by each cutting method, the value of timber that adequate control requires to be cut, the investment in roads necessary to cover large tracts, or the equipment and organization necessary.

The methods-of-cutting study at Blacks Mountain was advanced by establishing the third block of six treatments according to the plan to establish ten similar blocks, one each year. The natural reproduction phase of this study was retarded again by almost complete failure of the seed crop.

Mixed conifers. - A report was prepared for withdrawal of the first two tracts of an experimental forest in the sugar pine-ponderosa pine-white fir types in the Stanislaus-Tuolumne work center. The first of these tracts is a small administrative area - the site of present branch station headquarters. The second tract includes limited stands of virgin timber and a small area cut over in 1929 and is suitable for small plot experiments in the sugar pine-fir type.

Aerial photographs of the Stanislaus-Tuolumne center were completed by Region 5. These pictures were put to immediate use in designing a forest soil study.

Improvement cuttings

Thinning and release cutting studies have been relatively inactive for several years, partly because the series of field plots were thought to be so restricted as to limit conclusive results. The year 1940 marked the twentieth season of growth since initial treatment for the even-aged ponderosa pine thinning series and the sixth season for the sugar pine release series. With a view to possible closing of this project, field measurements were made and analysis is in progress.

Even cursory field observation suggests that there is promise in some form of release of sugar pine in mixed advance growth, perhaps even where sugar pine has been reduced to intermediate status by competition. Discouraging results of sugar pine plantings and consistent failure of natural reproduction focus interest on the 10 or 15 percent of this species in advance growth that might be restored to dominance.

Regeneration

Planting and seeding research since 1937 necessarily has taken the form of short-term, circumscribed studies closely geared to the immediate problems of the Region 5 planting program in northern California brushfields and fresh burns. Each study yields results on specific phases of planting, but how generally these results may apply is not apparent as yet. A memorandum summarizing findings to date is being prepared for Region 5. A publication of limited scope also is being written. For the present it is necessary to continue reporting briefly the separate studies.

Brushfield planting. - In the brushfields at Burney Spring (Blacks Mountain Branch), two similar studies were begun 4 years ago - one in the spring of 1937, the other in the fall of 1937. These plantations of 10,800 stock items each were designed to compare planting and seeding with ponderosa and Jeffrey pine sprayed and unsprayed stock after three brush eradication treatments of 1936: burning, stripping with trail builders, and both burning and stripping.

Fourth-season records for the spring plantation confirm earlier results reported fully in 1939, but some differences have become exaggerated. Survival percentages for the three brush treatments are now 79 percent for burned-stripped, 47 percent for burned, and 22 percent for stripped only. The average heights of planted stock for the three brush treatments in the same order now are 10.6, 5.2, and 3.3 inches. These differences are attributable almost entirely to selective damage by the Oregon snowshoe rabbit. In terms of surviving trees that are normal and have a chance to surpass the brush, none of the treatments can be rated successful at this stage. Indications are that with rabbits excluded all three treatments would be rated equally successful in terms of early survival and effects of returning brush competition might determine ultimate choice of treatments.

The fall planting belies the thought that rabbits and brush are the only effective obstacles to success. This plantation - in all treatment, species, stock, and spray classes - was a failure almost from the beginning, before the impact of the first period of rabbit injury. At the end of the third season, only 10.4 percent of the stock is alive. Soil moisture was available, and abnormal temperatures did not occur after planting. Cut-worms (noctuid moth larvae) destroyed important numbers of seedlings from direct seeding. With respect to loss of transplants, in the light of root studies, improper root pruning merits suspicion.

A rapid decline of plant nutrients in the soil during the year after clearing also is suggested. This possibility is supported by numerous successful plantings and natural seedings made at once after burning, logging, or clearing, as contrasted with dwindling survivals in plantings made 1 to 10 years after soil treatment. Convincing records should be made covering this phase of site effects. Its importance for programs of clearing, nursery production, and planting is obvious.

Season of planting. - Two-year records are now available for a plantation of ponderosa and Jeffrey pine at Feather River Branch designed to compare early survival and growth of 1-1 stock of three sizes, with and without winter buds, set out in fall and spring, with and without heeling-in and refrigerator storage. Survival is good - 88 percent. Losses in 1940 were only 2 percent, and the existing differences were apparent in the first year.

In survival, Jeffrey pine exceeded ponderosa by 2.5 percent; stock with hard winter buds surpassed stock without buds by 2.0 percent; the smallest third of the stock averaged 84.1 percent - significantly less than medium and large grades; stock lifted and planted in the fall averaged 91.3 percent, stock lifted and planted in the spring 93.7 percent, stock lifted in the fall, heeled-in, and planted in the spring, 88.2 percent, and stock lifted in the fall, refrigerated, and planted in the spring, 78.5 percent.

In height growth the fall lifted-fall planted large stock with hard winter buds was superior.

Of interest in planning future tests was the discovery that reliable comparisons leading to similar conclusions could have been made with only one-third as many stock items, if planted in the same design.

This study will be closed upon completion of the report.

Seed grades and stock grades. - Seed of ponderosa and Jeffrey pines sown at Feather River Nursery after grading by size produced seedlings in which top length was positively correlated with seed size. The seedlings were graded and transplanted in March 1940. The transplants will be graded and outplanted in the spring of 1941 for a 10-year test of survival and growth.

Stock condition. - A test of conditioning for planting by storage of standard Region 5 ponderosa and Jeffrey pine 1-1 stock was begun in November 1940 at Feather River. This study was prompted by frequent failures of outplanted stock to begin growth, coupled with observed responses of roots to pruning.

Scotch pine. - The Scotch pine provenience study, sponsored by the International Union of Forest Research Organizations, was initiated by sowing seed of the 17 proveniences March 20, 1940. Germination ranged from 4 to 88 percent for the different lots. Survival up to November for 13 of the lots was sufficient to provide seedlings for the transplant phase in 1941.

Feather River Nursery. - Feather River Nursery output amounted to 25,000 (1-1) transplants of ponderosa, Jeffrey, and sugar pines. About 15,000 of these were planted in local brush-fields by Region 5. Seedlings ready for transplanting total 61,000. Seed was sown in the fall of 1940 to produce 45,000 seedlings. A fair crop enabled seed collecting for 3 to 5 years' requirements. Soil was renewed in 10 of the transplant beds.

Silvics

Seasonal growth. - Field work was completed in 1939 for the first phase of the study of seasonal growth of the principal conifers at Stanislaus Branch and the results summarized last year have now been submitted for publication.

Measurements of the buds and seasonal growth of 114 ponderosa pines in 1940 at Stanislaus Branch indicate that length of winter bud and seasonal height growth are correlated in such degree as to warrant a test of bud length as a criterion for grading planting stock.

Root-pruning study. - Comparisons of water use and growth were completed for ponderosa pine seedlings with root tips excised and with roots intact in soil with moisture at 8.4, 10.4, and 15.4 percent of dry weight. The first two moisture percentages are 2 percent and 4 percent above the wilting point for sunflowers and the third is field capacity.

Water use by the trees with pruned roots was significantly less than for unpruned trees during the first 30 days. After 100 days, mortality for the pruned trees was twice as great as for the trees with roots intact.

Water use, height growth, and weight increase for the trees were nearly proportional to the initial soil-moisture percentages, but mortality did not vary significantly with original moisture content.

The trees showed no signs of distress when the moisture percentage decreased to the apparent wilting point for sunflowers -- 6.4 percent -- and wilting was not evident until the moisture content was reduced to about 3.5 percent.

Ponderosa pine seedlings pruned to root lengths of 3, 6, and 9 inches and grown in soil for periods of 20, 40, 60, and 80 days showed greater increases in number of long roots and number of all root terminals for the 3-inch pruning. The number of laterals decreased up to the 40-day period, increased only slightly by 60 days, and considerably only after 80 days' growth. The number of active root tips continued to decrease for 80 days.

These results strengthen the impression, derived from plantation mortality and soil-moisture records, that lack of available moisture is rarely the direct cause of the heavy, early losses in plantations, and that root pruning and rough handling of stock might be suspected.

Seed crops. - Cone counts and seed trap records for nine areas at Stanislaus Branch indicated that rodents depleted a fair cone crop to such an extent that catches of seed in traps were small. Practically no sugar pine seed matured. The major portion of the good seeds of ponderosa pine, white fir, and incense cedar fell during the first two 10-day periods in October. In terms of white fir seed, the catch on an acre basis was practically the same for light and Forest Service selection cuttings but was significantly lower for heavy industrial cutting.

Site factors. - Site factor and seedling behavior records were continued at the five Stanislaus stations, and the seeding phase was considerably extended by sowings of ponderosa pine, sugar pine, white fir, and incense cedar in six cover types with and without soil preparation.

A cooperative study of forest soils was begun with the Division of Soil Technology of the University of California, the first series of samples being collected at Stanislaus Branch. The Division also classified and mapped the soils for Blacks Mountain Experimental Forest.

Mensuration

Sampling methods. - Further progress was made in the development of sampling methods for inventories and for measuring the results of treatments.

A paper entitled "Estimation of volume in timber stands by line-plot sampling" was prepared for publication in the Journal of Agricultural Research. In it formulae are given for deriving the best unbiased linear estimate of volume and variance in sampling blocks of varying size and irregular shape by the line-plot method. It was shown that when line-plot sampling units vary in size the regression of volume on line length must be taken into account to insure unbiased estimates. The method is well suited to both intensive and extensive surveys when mapping has been completed beforehand.

A second paper entitled "Estimation of vegetation-type areas by linear measurement" has been accepted for publication in the Journal of Forestry. The method presented provides unbiased estimates of areas in different types and condition classes and provides for detection of changes associated with time or treatment. It is more economical than mapping and will be useful to land managers where a sensitive measure of change is desired to check on the efficacy of management practices.

Completion of the aerial photographs for the Blacks Mountain area by Region 5 provides the final field material required for a test of cruising methods proposed by the Forest Survey Division. Analytical work is to be undertaken in the spring of 1941.

Seed crops. - Continue cone counts and seed traps records for nine areas at Stanislaus Branch.

Site factors. - Continue five station records and seeding study at Stanislaus Branch. Assist the Division of Soil Technology, University of California, with continuation of forest soil study.

Mensuration

Sampling methods. - Continue efforts to develop sampling methods for resource planning competent to show small, short-term changes. Test forest survey method using aerial photographs.

FOREST MANAGEMENT

REDWOOD REGION

The most important recent development in redwood research is the establishment of the Yurok Experimental Forest in an area representative of northern redwood conditions. The new forest includes all the timbered area of High Prairie Creek, a small tributary of the Klamath River in Del Norte County. Although only 843 of the 2,200 acres comprising the unit have been acquired, the remainder is proposed for early purchase. The best and most accessible part of the forest is now available for development and use. The entire unit supports virgin stands representing a wide range of conditions, from the finest pure redwood in the region to pure Douglas fir or Douglas fir-brush types. Port Orford white-cedar, Sitka spruce, bigleaf maple, and alder are also found occasionally on the area in mixture with redwood and Douglas fir.

The forest is well adapted for harvest cutting experiments with which most of the research on this area will be concerned. The primary objective will be to develop and demonstrate the most desirable method of management of northern redwood stands based on tree selection. Although solution of the main problem will require experiments covering many years, they will be designed so as to contribute within a short time to the improvement of private cutting practices and provide the basis for tentative management plans for national forest timber. The establishment of redwood log and tree grades, improvement of logging and slash disposal methods, and determination of the conversion value of trees with respect to size and grade should have high priority among the short-term objectives.

Previous research in redwood has been restricted of necessity to private lands where assurance of adequate protection and complete experimental control has been lacking. Consequently work has centered on short-term regional studies of the results of private planting; the condition of cut-over lands; methods, damage from, and costs of logging; increment of even-aged second-growth and residual trees; and the preparation of badly needed redwood volume and taper tables. Work has also been done on slash disposal and the problem of natural regeneration. These studies have supplied data of value to private operators, have aided in the improvement of current woods practices, and have provided a background necessary for the initiation of more intensive long-term experiments. It has been recognized, however, that the major problem is the efficient conversion of the remaining 350,000 acres of virgin redwood stands to fully productive managed forests. Now that an experimental unit has been established, a large part of the limited resources available for redwood research will be concentrated on this problem.

Summary of plans for 1941

Harvest cuttings

Ponderosa pine, Blacks Mountain. - Continue preliminary salvage - insect control with cut of about three million feet. Continue cooperative insect control studies with Bureau of Entomology and Plant Quarantine. Strengthen operating cost - mill recovery studies. Extend methods of cutting study by fourth annual replication.

Mixed conifers. - Maintain established studies with thirtieth-year records. Complete action for withdrawal of an experimental forest in sugar pine types.

Improvement cuttings

Analyze and report thinning and release plot records taken in 1940.

Regeneration

Brushfield planting. - Make the annual examination for the fourth and fifth seasons of the two Burney Spring plantations.

Season of planting. - Complete report and close the Feather River 1938 study.

Seed grades and stock grades. - Complete transplant phase records and carry through out-planting phase of Feather River study.

Stock condition. - Complete spring plantings and maintain records at Feather River.

Scotch pine. - Complete transplant phase.

Feather River Nursery. - Continue limited production of stock for experiments and Plumas administrative planting. Continue soil-improvement program.

Silvics

Seasonal growth. - Complete analysis of data and publications.

Root pruning. - Report pruning phase. Report water-use phase. Initiate study of conditioning stock for quick root regeneration.

Seed crops. - Continue cone counts and seed traps records for nine areas at Stanislaus Branch.

Site factors. - Continue five station records and seeding study at Stanislaus Branch. Assist the Division of Soil Technology, University of California, with continuation of forest soil study.

Mensuration

Sampling methods. - Continue efforts to develop sampling methods for resource planning competent to show small, short-term changes. Test forest survey method using aerial photographs.

FOREST MANAGEMENT

REDWOOD REGION

The most important recent development in redwood research is the establishment of the Yurok Experimental Forest in an area representative of northern redwood conditions. The new forest includes all the timbered area of High Prairie Creek, a small tributary of the Klamath River in Del Norte County. Although only 843 of the 2,200 acres comprising the unit have been acquired, the remainder is proposed for early purchase. The best and most accessible part of the forest is now available for development and use. The entire unit supports virgin stands representing a wide range of conditions, from the finest pure redwood in the region to pure Douglas fir or Douglas fir-brush types. Port Orford white-cedar, Sitka spruce, bigleaf maple, and alder are also found occasionally on the area in mixture with redwood and Douglas fir.

The forest is well adapted for harvest cutting experiments with which most of the research on this area will be concerned. The primary objective will be to develop and demonstrate the most desirable method of management of northern redwood stands based on tree selection. Although solution of the main problem will require experiments covering many years, they will be designed so as to contribute within a short time to the improvement of private cutting practices and provide the basis for tentative management plans for national forest timber. The establishment of redwood log and tree grades, improvement of logging and slash disposal methods, and determination of the conversion value of trees with respect to size and grade should have high priority among the short-term objectives.

Previous research in redwood has been restricted of necessity to private lands where assurance of adequate protection and complete experimental control has been lacking. Consequently work has centered on short-term regional studies of the results of private planting; the condition of cut-over lands; methods, damage from, and costs of logging; increment of even-aged second-growth and residual trees; and the preparation of badly needed redwood volume and taper tables. Work has also been done on slash disposal and the problem of natural regeneration. These studies have supplied data of value to private operators, have aided in the improvement of current woods practices, and have provided a background necessary for the initiation of more intensive long-term experiments. It has been recognized, however, that the major problem is the efficient conversion of the remaining 350,000 acres of virgin redwood stands to fully productive managed forests. Now that an experimental unit has been established, a large part of the limited resources available for redwood research will be concentrated on this problem.

Of particular interest to administration and the redwood industry among 1940 accomplishments, is the completion of the taper and volume tables for redwood which will provide a more accurate basis for valuation surveys and logging and milling studies. Because of the difficulties involved, regional tables adaptable to different areas and utilization standards have not previously been available. The analysis of increment cores from residual trees was also completed and a report is being prepared on the effect of release on trees left after logging with respect to tree diameter at the time of release and site. Preliminary study of records of the 1940 examination of the selectively logged Henry Creek reproduction quadrats supports previous conclusions as to the beneficial effect of moderate to severe slash-disposal fires on the establishment and growth of redwood reproduction. Noteworthy also is a rather marked acceleration of growth of planted redwood, which became particularly noticeable in 1940, after a very slow rate of growth for the first 10 to 15 years since planting.

Cooperation with other governmental divisions and agencies and private companies assumed considerable importance during 1940. Among the most significant of the many and varied projects were the preparation of material for administrative use on current conditions in the redwood region, cooperation with fire research on a study of methods of hazard reduction for use in redwood lumber yards, assistance to the Securities and Exchange Commission and the Reconstruction Finance Corporation on cases involving redwood timber, and assistance to the Division of Products in the collection of data for the lumber census.

Progress and Plans

Illustrative high lights of recent accomplishments on active projects and plans for 1941 follow:

Establishment of Natural Reproduction

With the completion of the 1940 examination there is now available the record of five annual examinations of 300 reproduction quadrats from the selectively logged Henry Creek area. Since it has been found from other studies that very few seedlings become established later than 5 years after logging and slash burning, because of competition from other vegetation, this will complete the field work for the first phase of the study. The records are now being prepared for statistical analysis, including the computation of regression curves to evaluate the effects of slash and seed-tree density, competing vegetation, exposure, and degree of slash-burn on the establishment of Douglas fir, white fir, and redwood seedlings. Preliminary examination of the 1940 records support earlier trends (reported in detail in 1939) with respect to exposure and the beneficial effect of moderate to heavy slash fires on the germination and survival of redwood seedlings.

The very rapid replacement of the tall herb (fireweed) type, which invaded the area immediately after burning, with herbs, ferns, and shrubs of the virgin redwood type is also of interest. A report covering this initial seedling establishment period will be prepared this year. Subsequently the quadrats will be re-examined every 5 years to determine ultimate survival and growth of the seedlings with respect to the factors mentioned.

The manuscript on the earlier, extensive study of natural regeneration on redwood cut-over lands is undergoing another revision in line with suggestions made by the Washington office.

Survival and Growth of Planted Redwood

This study also has reached the point where analysis of accumulated data and publication of results is in order. Records from 96 plots for the years 1937, 1938, and 1940 are available. The growth of these trees, which were planted between 1925 and 1930, has been surprisingly slow, the mean annual growth in 1937 being only .53 feet. Acceleration of growth since 1937 has been marked on many of the plots, with the result that the average annual growth for the period 1937 to 1940 increased to .87 feet. The effect of slope, exposure, and vegetation-type on survival and growth will be analyzed. The plots will be examined again in 1945 and thereafter at 5-year intervals.

Volume and Taper Tables

The redwood volume and taper tables based on six different utilization standards have been completed and are being prepared for general distribution. Tentative Port Orford white-cedar volume and taper tables were mimeographed and distributed early last year.

Increment of Residual Redwoods

In the absence of regulation, improvement in forest practice on private lands in the redwood region is dependent on the ability of foresters to convince private operators that selective cutting and the protection of residual trees is economically worth while. To do this more reliable estimates of the increment of residual trees are needed. One thousand increment cores from 400 trees have been studied to provide a better basis for these estimates. The average annual basal area increment for 20 and for 30 years following release have been computed, and the data are now being analyzed to determine whether a consistent relation between tree diameter at time of release, density of residual stand, and site quality can be shown. A report will be prepared during 1941.

New Problems

Of first importance in redwood research at this time is a work plan for methods of cutting studies to be undertaken on the Yurok Experimental Forest. A problem in this connection is the preparation of a redwood tree classification system. This is much more difficult than for most other species because of the extreme range of tree sizes and ages and because of the difficulty, if not impossibility, of using crown characters in dense virgin stands. Bark characters in connection with tree diameter offer the most promise at present, and work on this study will be pushed.

Although some work has been done on slash disposal it remains one of the most serious limitations to better woods practice. On a considerable part of the 50 percent of current logging done with tractors, damage from slash-disposal fires causes serious loss of residual trees and in many cases leaves the areas in an unproductive condition. Slash-disposal studies should therefore be considered an important part of the harvest cutting experiments to be undertaken on the experimental forest.

Of equal importance to the Divisions of Forest Management and Forest Products is a better basis for determining the conversion value of redwood logs and trees. The Division of Management will assist with logging and milling studies designed for this purpose as soon as the cooperation of a private operator can be obtained.

FOREST MANAGEMENT

FOREST FIRE PROTECTION

All the forest land in California, approximately 48 million acres, requires some degree of protection from forest fires as a part of its successful management. There are four outstanding resources in the mountainous areas of California -- timber, forage, water, and recreation -- the individual management requirements of which largely define the needs for protection on most of these lands.

Control

The fire-control objective is to provide at an equitable cost the degree of protection needed to satisfy the management requirements of each resource and its use. The present management objectives have been established in terms of average annual allowable burned areas in California as 0.2 percent for timber management in the pine region and approximately the same for redwood; in Northern California, 0.5 percent for grazing and watershed lands; and for the watersheds of southern California 0.15 percent, with the added objective of limiting the size of individual fires to 2,000 acres. A growing recreation business within the mountainous areas imposes an additional requirement for intensified local protection over and above that required for management of the other resources. Recognition of the watershed values of commercial and potential timbered areas and reevaluation of the role of water in the State-wide economy will tend toward more intensive protection on all these lands.

The present objectives for allowable burned areas are being rapidly approached on much of the area protected by Federal and county agencies, or on approximately two-thirds of the forest land in California. Progress has been made at a somewhat slower rate toward adequate protection of the remaining third under State jurisdiction.

Suppression

The fields of presuppression and suppression have made the largest gains in recent years. Planning for detection, communication, and transportation, and for placement of manpower, each on a region-wide basis, have combined to raise the general level of protection materially. Better training of both regular and short-term personnel, the general use of trained stand-by suppression crews, and the introduction of fire-danger rating have been other outstanding advances in the field of presuppression. Similarly, the development and better application of improved fire-fighting techniques, fire generalship, power-line building equipment, tank trucks, radios, and

airplanes have tremendously increased the effectiveness of fire-suppression effort. The total number of fires has continued to increase, but only as use has increased tremendously. The decreasing number of fires per user day or other unit basis, however, reflects major progress in prevention, particularly among hunters and stockmen. The role that research has played in this development, particularly through its contributions toward better methods and practices in the fields of pre-suppression and suppression, has been an important one.

Although improvements in methods, practices, and facilities have been many, no portion of the protection problem in California has yet reached a wholly satisfactory status. Throughout the entire field of forest-fire protection the lack of quantitative information and frequently even qualitative information concerning the ways fires behave, the damages and benefits they cause, or the effectiveness of prevention and control measures, is a critical factor obstructing further progress.

Some Critical Problems

A few of the outstanding problems submitted by fire-control administration as in need of immediate solution may serve to outline the scope of the work still ahead. The list includes only a few of the high lights and is in no sense complete.

Measurement and evaluation of the effectiveness of possible prevention activities as a basis for selecting the short-term measures best suited to high fire danger resulting from different causes.

Speed and strength of attack necessary for adequate protection to serve as a basis for determining the proper distribution and strength of manning of fireman stations and the proper balance between man-power and tank truck equipment.

Maintenance of a proper balance between intensity of protection and the seasonal and short-period fluctuations in need for protection.

The balance between tank trucks and suppression crews in a presuppression organization and between power-line building equipment and hand labor on the fire line.

The amount of fire line to be expected from power equipment and from hand labor of different kinds and sources used in various manners under different working conditions.

How to achieve most thorough application of what is already known of all phases of protection.

Measurement and evaluation of the beneficial and detrimental effects of fires and methods for predicting these effects.

The place of controlled burning in the management of the forest and range lands of California.

The recognized place of research in the solution of these fire-control problems is in obtaining the basic information required and in suggesting methods by which it may be applied. Detailed analysis of past fire history and control accomplishment records, and applied research in the fields of behavior, control, effects, and economics provide the means by which the needed information may be obtained.

The long-term fire-research program of the California Station is aimed at solution of the phases of each major problem that are susceptible to research attack by available personnel and facilities in the order in which added information may be expected to yield the greatest protection benefits.

One basic problem of fire control -- determination of the speed and strength of initial attack requirements for adequate protection of each of the major California cover types -- occupies first place in the current research program. Present effort is confined to two aspects of the problem in the respective fields of behavior and control. The immediate objective in the behavior project is to determine the rates of initial spread of fires burning under all the combinations of wind, moisture, fuel type, and topography common to California. The primary objectives of the control project are to make available, through analysis of past fire history and accomplishment records, data and trends in suppression effectiveness which can be used as indices of the results of different combinations of speed and strength of attack to be expected from modification of present practices; to determine through practical study the rates of line construction to be expected from different power-line building units and from hand labor working under all the different conditions encountered in the suppression of fires in California cover types; to determine through field study the most effective balance between tank truck equipment and different sizes of suppression crews; and to determine the effectiveness and proper specifications for firebreaks.

During the past year considerable progress was made in determination of the relationship between the rate of spread of fire and the variables, wind velocity, fuel-moisture content, and physical characteristics of the fuel. This, together with the current development of better methods for sampling and measuring wind and fuel moisture in the field as reported last year, made

possible immediate application of results in the field of fire-danger rating. The new rate-of-spread data have been utilized in a complete revision of the Region 5 spread index, and the proposal has been submitted for modification of current methods of measuring wind and fuel moisture for danger-rating purposes.

Analysis of southern California fire statistics was continued with special emphasis on the analysis of the influence of past variations in speed and strength of attack upon the effectiveness of protection as a basis for planning more intensive protection on the southern forests. The results of this work have been included in a manuscript for publication under joint authorship of the Experiment Station and the Region.

In addition to these two studies aimed at an immediate objective in the long-term program, study was also undertaken of the special problem of detection on the Angeles National Forest. On that area haze and mottled backgrounds against which smokes must be observed appear to combine to create a detection problem differing considerably from that of any other California national forest. The study is to be continued through another field season.

A final major accomplishment of the past year has been completion of a State-wide problem analysis of the whole field of fire control. The analysis consists of (1) a condensed summary of fire protection needs, (2) a review of the major problems confronting the fire control agencies with discussion of the manner in which different parts influence forest protection, (3) evaluation of the relative importance of the problems to fire-control development, (4) consideration of the susceptibility of different parts of the problems to research attack, and (5) development of a long-term fire-research program.

Only minor adjustments in the present program have been necessary to bring current effort into line with the need for research on problems of highest priority at the present time. The analysis adds considerable emphasis to the need for continued research in fire behavior and to the need for immediate attack in the fields of fire effects and fire-protection economics. The analysis indicates nothing to be gained at the present time, however, by transfer of effort now devoted to control and behavior studies to these new fields. Studies of rate of spread and its controlling variables and of manpower and equipment effectiveness will continue, in the absence of additional personnel, to constitute the major program during the ensuing year.

FOREST MANAGEMENT

FOREST GENETICS

The Genetics program is directed along two major lines of research, namely, selection and hybridization. For convenience of discussion a third category, fundamental studies, is added. Studies in the latter class contribute to the major lines of research by supplying fundamental information essential to the solution of the problems of tree breeding and include investigations relating to the cytology, morphology, taxonomy, physiology, and biochemistry of the pines. There can be no sharp line of demarcation between fields in tree breeding, a considerable overlapping of spheres of work being both necessary and desirable. The few selected illustrations of going and proposed work outlined in this report will serve to indicate the close relationships existing among the seemingly divergent fields of investigation.

Close coordination of all lines of work is necessary, however, in order that duplication may be prevented and that all effort may be expended in the solution of problems of primary importance. A concerted attack on the problems by the various staff members, using all available techniques, promises greater returns than from unassociated individual efforts. Much of the laboratory work is conducted in Berkeley, but most of the field work on native pines is carried on along what is called the El Dorado transect, a belt several miles wide traversing the Sierras from Folsom to Echo Summit, paralleling U. S. Highway No. 50.

Results and Plans

Selection

The selection work includes species tests, progeny tests, transect nurseries and plantings, provenience studies, and much of the work on adaptation and field testing. The older tests are now on a maintenance basis, and current effort is being concentrated on the analysis of data and the presentation of accumulated results. While yellow pine occurs at elevations from 200 feet to 6,500 feet in this latitude of the Sierras, there is a statistically significant indication that trees from the 2,000- to 3,000-foot elevational zone of the El Dorado transect are hereditarily more vigorous when grown at elevations of 900, 2,700, and 5,700 feet than trees from any other elevational zone of this transect. Should they prove resistant to heat and drought at 900 feet and resistant to cold at 5,700 feet, their use over a wide range of altitude in the Sierras can be recommended. This is contrary to the generally accepted principles of provenience, but it now seems possible that more complete data may show ponderosa pine to have a greater degree of adaptability to climatic changes than has heretofore been suspected. A definite answer to this important question will be welcomed by those engaged in reforestation activities.

Hybridization

In the past history of this Division effort has been concentrated on selection work, as this seemed the most promising avenue toward quick results. Now that the initial work in developing the program of progeny tests has been completed, more effort will be directed toward the hybridizing phase of the work. At the present time there are on hand at the Institute from 8 to 12 species crosses, depending on one's concept of a species. The hybrid plants indicate certain general principles of inheritance among the pines. Complete dominance of particular parental characters is not found in most of them, pronounced hybrid vigor has not occurred to date, and derangement of the chromosomes has not been detected. As the behavior and inheritance of characters have been much the same in all hybrids, it is now possible to predict with some degree of assurance the results to be expected from any cross planned. On this basis hybridization work is now planned with such definite purposes as extending the range of certain valuable timber species, increasing the vigor of others, and introducing into others resistance to cold, drought, pests, and disease. For example, a white pine that is immune to blister rust is needed. Some thirty millions of dollars have been spent on Ribes eradication work, yet the blister rust continues to spread. Although the yellow pines are immune to this disease, all white pine species tested have proved to be susceptible to it. Some species and strains of white pine are known to be somewhat resistant to the disease, but resistance is only a relative condition. As with wheat rust, virulent forms of most diseases may be expected to develop on the relatively resistant strains. Likewise, as with wheat and other field crops, the solution lies in hybridizing an entirely immune species or race with the susceptible species and thus introducing immunity - not merely resistance. The timber species of yellow pine are too remote phylogenetically to hybridize readily with white pine or sugar pine, as demonstrated by the failure of several efforts in this direction. In California, however, two pine species, the foxtail pine and the bristlecone pine, are intermediate in relationship between the white and the yellow pine groups. In the summer of 1940 an attempt was made to cross several species of both yellow and white pines with each of these species. The results of this work will not be known for two seasons, but the potential value of a white pine immune to blister rust makes this exploratory work of considerable importance and interest.

Fundamental Studies

Under fundamental studies are grouped several lines of activity. The results of these studies will apply either to the selection program or to the hybridizing or breeding program, but as they are of such diverse nature it seems well to discuss them separately from the two major lines of research.

Perhaps the most promising result to date from physiological work is the correlation between the growth-hormone content and the actual growth rate of pine seedlings. In the plants tested the more vigorous strains and individuals showed greater hormone concentration when assayed quantitatively. This work to date has been done exclusively with young seedlings, but it should be repeated with material from mature trees. Seeds can then be collected from these trees and the seedlings produced by them may be analyzed for hormone content. Should this correlation prove to be constant throughout the life of the individual trees, it may be possible by hormone analysis to select the most vigorous strains and individual trees from our forest populations. The practical value of the application of such a method to the marking of seed trees on a sale area warrants further research in this direction.

Identification is essential in all tree breeding work, as it is by taxonomic characters that strains, hybrids, and outstanding individuals are selected. Identification of breeding stock is necessary at a very early age in order that undesirable plants may be eliminated. Because there are no fruits on these young trees, characters of the needles, buds, and stems must be used. Recent studies indicate that the stomata of the needles may be more reliable criteria than needle cross sections or any of the other juvenile characters previously used. In some cases positive identification is possible at a very early age by the use of stomatal characters, but in other cases, notably among some of the Southern pines, stomatal differences are insignificant. The results suggest that some of these latter forms may not merit specific rank, but should be relegated to subspecific or varietal categories. Stomatal analysis is possible only at a magnification of 50 diameters or more, which probably accounts for the fact that it is not used by the taxonomists equipped with an ordinary hand lens of low magnification.

New Work

Completion of the building program has reduced the load of administrative work of some of the staff members to such a degree that it may be possible to undertake some new work without increasing the costs of the Institute or the work load of the staff members. It is hoped that the placing of the progeny test program on a maintenance basis in the spring of 1941 will further relieve the technical and labor burden. Should new work or new phases of old work be possible, several projects have been selected for consideration.

Trees from 10 to 15 years of age representing a majority of the pine species of the world are growing in the Eddy Arboretum of the Institute of Forest Genetics at Placerville, Calif. Some of these have proved to be perfectly hardy at this Station and to have such desirable traits as rapid growth, great total cellulose production, and good form, and others have proved to be susceptible to frost injury, snow damage, drought, and other adverse conditions.

In order to acquaint research workers, Forest Service personnel, and others with the plant material and facilities available for study and research work at the Institute, a short booklet describing these resources is planned. Such a booklet has seemed in order for some time.

In order to establish the reliability of the one parent progeny test method, controlled breeding tests or repeated progeny test will be necessary. A progeny test, the method of testing the inherent characteristics of a seed tree by the offspring it produces, is very expensive when carried out under experimental conditions such as those maintained at the Institute, and furthermore the applicability of the results of these tests to the general forest planting program is open to question. In order to learn whether the trees which have produced exceptionally vigorous progenies under test conditions will continue to produce such progenies year after year, especially under field conditions, it is planned to enter the field-testing phase of the progeny test. For these field tests, seeds will be collected from the forest trees which have produced superior progenies under experimental conditions. These seeds will be planted in cooperation with the nurseryman in the Forest Service (Region 5) nursery and will receive the same care as other seed collections designed for general reforestation purposes. By using the test material in every second or third row, data can be obtained on its general fitness and desirability, but should it prove unsuccessful it will be eliminated by natural competition or by thinning. If, on the other hand, it proves to be superior to the standard planting stock, it may be used to produce the final mature stand of the area. In either case the inferior of the two stocks would supply the environment needed to produce good form, quality, and height growth in the dominant trees. The testing of promising strains, hybrids of unknown capacity, or any other stock may thus be carried out without risk to the reforestation program as practiced today. From this fundamental concept of test planting, many obvious implications can be seen, and it is hoped that a new impetus to tree breeding may result from its application.

The production of nursery stock by water-culture methods should also be tested. This method has heretofore seemed prohibitive in cost, but a careful analysis reveals many advantages and indicates that the cost per surviving tree in the forest may be no more than the cost under current practices. For instance, no expense is necessary for soil preparation, weeding, watering, or digging, and the plants are under perfect control with an optimum amount of food and water at all times. Under these conditions seedlings are able to develop to the full extent of their potential capacity. It is well known that plants or animals stunted during their initial development seldom reach the proportions of similar organisms that have suffered no setback in growth.

It is therefore not surprisingthat preliminary tests indicate that the survival and early growth of water-culture seedlings when planted out in the soil are greater than the survival and early growth of seedlings dug from the seedbeds. Although this may be due, in part, to the more vigorous stock, it seems probable that the complete and uninjured root system of the water-culture seedlings may be largely responsible. From the experimental point of view one more variable — root injury — is controlled by this method, but for practical purposes a valuable method of producing superior planting stock may result.

Looking Ahead

The genetics program is at a critical period in its development. Early experiments have developed sufficiently to be evaluated. Much fundamental information has accumulated. Recently inaugurated techniques and methods are beginning to reveal their possibilities. This, therefore, seems to be a most opportune time to submit the entire genetics program to a searching analysis, reexamining objectives, weighing the methods and techniques employed, and questioning the theoretical validity of the assumptions on which each line of experimentation rests. Such an analysis is in the process of preparation, and on the basis of the findings it is hoped that the program can be so oriented that a high degree of productivity can be maintained.

RANGE MANAGEMENT

Significant findings during the year just past have brought us clearer understanding and nearer to solution of the more vexing problems facing national-forest administrators, livestock operators, and the livestock industry in general. The problems are big because they concern half the total land area of the State and cut across practically every land use. And, as detailed in previous reports, the problems are in large part peculiar to the California region.

In addition to the normal number of range problems, new ones already are looming up as the national-defense program begins to take shape. As in the first World War, the importance of range as a vital resource brings new pressures and problems.

Range research effort during 1940 was concentrated in two range regions: Foothill studies aimed at the development of better range-management practices on "annual type" cattle ranges were centered at the San Joaquin Experimental Range in Madera County adjacent to the Sierra National Forest. The mountain project, with similar objectives for perennial range types, was handled from the Blacks Mountain Branch Station and dealt with problems common on the Lassen National Forest and "eastside" ranges.

Foothill Ranges - San Joaquin Valley

The major accomplishment of the year was completion of an analysis of findings to date and an interagency report now undergoing final review for publication as a University of California bulletin. The concerted group attack on foothill range problems is reflected in a foreword by the Dean of the College of Agriculture, University of California, and by the Director of the California Forest and Range Experiment Station, and by separate chapters or sections contributed by the various cooperating agencies participating in the program.

Significant trends of results relating to efficient range utilization and sustained forage production are illustrated in the following selected highlights:

1. Three distinct forage periods contribute to the whole problem of foothill range management. The first extends through 4 or 5 months of the summer when feed is mainly dry and low in nutritive values; the second is a period of 3 or 4 months during the fall and winter when green feed starts at the beginning of the rainy season but makes little growth and is generally uncertain or insufficient; and the third period covers 3 to 4 spring months during which rapid growth occurs and the principal forage plants ripen.

2. Ten to 12 inches of rain with favorable distribution and temperatures may make a better forage crop than 25 to 30 inches with unfavorable conditions. More facts on the relationships between weather and forage, for even a short period in advance, would be of immediate practical value to the operator.

3. Some left-over dry feed means earlier green feed. New green growth has been available from 2 to 3 weeks earlier on areas where some old feed has been left to serve as protection than on areas closely used the previous season.

4. Under the conditions of this study, forage composition and density were not appreciably affected in 3 years by the three different rates of use for the grazing period of approximately 7 months each year.

5. From the standpoint of grazing capacity, cattle weights, although difficult to interpret at this stage of the experiment, show that the gain per animal unit was smallest on the exceedingly close grazed pasture. The effects on the cattle of the different intensities of grazing are discussed in detail by the animal husbandmen of the University in their chapter on experimental herd management in the forthcoming bulletin.

6. Forage composition and density may be readily changed by complete exclusion of grazing. On the better sites, litter accumulates rapidly and an inferior quality of forage may develop within 2 years. Thus, from present indications, such annual ranges can be grazed too lightly — as well as too closely.

7. Two classes of range indexes, animal and plant, complement each other. Both are important in range appraisal and especially so in this type of range forage because of its big and sudden changes.

8. In the artificial revegetation studies the promise shown by a few species warrants increased emphasis on further and wider testing.

Apart from the range-research program at the San Joaquin Experimental Range, results of past range work, particularly the western range survey of San Benito County (reported in the 1938 report) were heavily drawn upon during the year for incorporation in flood-control-survey reports.

Plans for 1941 contemplate no major change in objectives of the foothill project but slight changes in approach may be recommended later as a result of analysis of work to date and of recent advances in experimental design.

Mountain Ranges - Eastside Pine

During the past year effort was devoted primarily to (1) the completion of an analysis of the main range problems confronting Forest Administration on eastside ranges of the Shasta, Modoc, Lassen, Plumas, and Tahoe National Forests in northeastern California, and (2) the orientation and start of a long-range research program in line with the analysis. The analysis is a concrete expression of the agreement reached by Research and Administration, after many field and office consultations, on just what are the most important problems of range-resource management on eastside national forests, and the order in which these problems should receive research attention and administrative action. It is planned to complete local forest reviews and forward the analysis to Washington in April.

This problem analysis is already stimulating even closer cooperation between Research and Administration and is making research a more useful tool in forest administration. It represents the views of the Forest Service (R-5) and serves as a base for discussing mutual problems with other groups and agencies and for cooperating with them in the solution of those problems. It covers the following subjects: utilization standards, season of range use, fluctuations in forage production, livestock control and management, artificial and natural revegetation and erosion control, livestock grazing versus wildlife, and livestock grazing versus timber production. Almost every field problem touches on each of these to some degree, and their relative importance depends largely on local circumstances.

The analysis clearly shows that the solution of practically all the problems concerned with the utilization of the resource depends on sound data on basic management factors as exemplified by the first four subjects. It further shows that, while some of the problems (for example, erosion and conspicuous deterioration of the forage) are readily seen on the ground, others are not so apparent and are detectable mainly in economic calculations. Many local problems arise simply from the lack of definite information to guide efficient management.

After consideration of such additional factors as status of going work, manpower, finances, and need for the information, the following studies have priority in work proposed for 1941: season of range use, artificial and natural revegetation and erosion control, utilization standards, and livestock grazing versus timber production.

Season of Range Use

The problem analysis revealed that on many cattle ranges in the eastside region, meadows are closely utilized in contrast to light or almost no use on adjoining timber types of high grazing value. This uneven use has resulted in range deterioration in some areas and very likely to suboptimum returns from the range allotment as a whole.

Information is needed on the relative grazing value of these types and their season of most profitable use consistent with maintained production, in order to calculate how much may be invested in management to effect better utilization.

Past research at Burgess Spring has revealed the high values that may be derived from cut-over timber types. For example, daily cattle gains on the Burgess Spring Experimental Range averaged from 1.4 to 2.0 pounds for the summer grazing season. Comparative figures for meadows are needed. Another finding: the timber type should probably be utilized sooner than the meadow, because of its earlier development. This season-of-use relationship between timber and meadow types is very important in the management of eastside range allotments, and plans for its study on the Lassen National Forest were nearly completed during the past year. The Burgess Spring area has been selected as the timber type and a portion of the adjoining Squaw Valley as the meadow. The areas have been examined and approved by Administration (Regional Office and Lassen National Forest) and Research. The location of fences and improvements (mostly in the meadow — approximately 160 acres) has been agreed upon. Arrangements are being made by the Lassen National Forest to obtain cattle from a permittee for use in the experiment.

Completion of plans for this study is scheduled for April. Necessary construction should be completed during the year and results of even the first year (1942) should have comparative significance.

Revegetation

The first results obtained by Research on artificial reseeding in the pine region were recorded during 1940 on the Lassen National Forest from two fenced areas sown to mixtures of crested wheatgrass and smooth brome by Administration in 1934. One area (Dry Lake) was in a depleted sagebrush type; the other (Norvel Flat) was partly deteriorated meadow and partly heavily grazed sagebrush.

A very satisfactory stand of the sown species became established on the meadow site in Norvel Flat after 6 years, but practically no survival was obtained in the sagebrush types. On the Dry Lake area the sown species made up about 5 percent of the forage stand. Study of the causes of failure — and of partial success — is needed.

The striking observations on these plots were the catch of native species in the drill furrows and the rejuvenation of the native stand under fenced protection. They encouraged the idea of increasing the native forage and perhaps the original sown species by further harrowing under continued protection. Five pairs of exploratory plots were set out and treated and will be remeasured in 1941.

Data on natural and artificial reseeding are in much demand by Forest Administration and livestock operators, and work will be

carried on in this field in line with the problem analysis. First efforts will be directed toward examining all existing fenced areas that were planted by Administration on eastside forests in past years. The results, to be made promptly available, will be used to guide future effort in actual reseeding trials and to direct research.

Utilization Standards

Bitterbrush (Purshia tridentata) is one of the key forage species on which a complete life-history study, including determination of how much grazing it can withstand, is urgently needed. The lack of young bitterbrush reproduction and the poor vigor of the older plants over large areas on eastside range allotments have made this need felt. The problem is more acute in local areas, especially on the Modoc National Forest, where deer as well as domestic livestock seek out this "ice cream" species.

During the past summer the stage was set on the Modoc National Forest for determining the effect of heavy soil disturbance (comparable to logging) on the establishment of bitterbrush seedlings and on the vigor of the bitterbrush plants not destroyed by the treatment. Plots were established in virgin-pine areas on which the soil had been torn up with a tractor and ripper, by Administration, for another purpose. Measurements in 1941 will yield the first set of data on the effect of this treatment on bitterbrush. Pending specific studies in the life history of bitterbrush, the attempt will be made to gather data in 1941 on the character, condition, and age-class distribution of bitterbrush on samples of ungrazed range to be used as natural substitutes for fenced plots.

Livestock Grazing versus Tree Reproduction

Review of the past work and further discussions with Administration have definitely directed our next research effort to a specific problem and a major question. The problem: Many cut-over areas in the eastside pine region are not satisfactorily restocking with pine reproduction soon (1 to 8 years approximately) after logging — the period when conditions are apparently most favorable to the establishment of reproduction. The question: Is grazing, particularly by sheep, an important factor in the failure of these areas to become restocked with trees?

Previous work at Burgess Spring, in emphasizing this problem, has shown that grazing damage to established pine reproduction is negligible and does not loom as a serious regional problem. This has narrowed attention to the study of first-year seedlings. Measurements indicated that grazing damage by cattle to seedlings was not serious. Data on the effect of sheep grazing were inadequate. This left a need for further work with sheep and 1-year-old seedlings. This is in line with Administration's views on the localization of the problem.

Burgess Spring work has also been useful in developing study plans; for example, it has been found that pine seedlings from artificially planted seed cannot yet be obtained in sufficient numbers for experimental purposes. It necessitates taking advantage of natural catches as they occur in the field, and it is planned (subject to Investigative Committee and Washington approval) to use two kinds of plot installations: (1) A system of about 50 fenced plots with checks which can be set up on a suitable area and the establishment and growth of pine seedlings followed over a period of years, regardless of rate of seedling catch; and (2) a smaller installation of about 4 plots which can be quickly set up when and where a large seed crop is in evidence and a heavy catch of seedlings is anticipated. Initial work will be started with the smaller set-up because of its flexibility, the greater probability of obtaining seedlings for study, and the smaller cost of construction and maintenance.

FOREST PRODUCTS

The work of the Division of Forest Products, covering the wide field of utilization, is intimately interrelated to the work of several other Divisions, particularly Economics, Pine, and Redwood Management, and the Forest Survey to which we must go for information on the supply of woods for which markets are sought.

The most important development in the field of utilization during the past year was the increased demand for lumber and other forest products owing to the national defense program. While much of it may be temporary, there is developing with it a large demand for lumber for industrial construction and housing. One of the most interesting developments in California is the production of piling from Douglas fir, white fir, and ponderosa pine, largely because of the restriction of the supply of piling from the Pacific Northwest resulting from shipping difficulties. It may mean the establishment of a permanent piling-producing industry in the State, particularly in the lower redwood and westside Sierra foothill areas.

As in 1916 and 1917 there has been an increased interest during the past year in domestic sources of burl for tobacco pipes since European sources of supply are cut off. There have been some letters of inquiry concerning burl sources and quality in California and some personal investigation by Eastern pipe manufacturers. Several California shrubs are known to produce burls suitable for pipes. In spite of the large areas over which these shrubs grow, particularly the manzanitas, little is known about the actual quality of burls on various areas, their size, and the quantities available. In view of the interest in the matter and the possibility of its furnishing local employment in certain areas within the State, the Products Division plans to investigate some of the burl sources during the coming year.

Results and Plans

Logging and Milling Studies

Remaining field data were completed on the mill study at the Fruit Growers Supply Company on trees of different insect-risk classes (as defined by the Bureau of Entomology, Berkeley) taken from the Blacks Mountain Experimental Forest. Results were computed and analyzed, and the report was completed. Although the scope of the study was not sufficient to permit the drawing of definite conclusions, the results indicate that high-risk trees are not necessarily high-value trees. It is planned during the coming year to conduct another mill study of a comparable type to check results on the earlier work and to obtain adequate data on the very important question of value of trees of various insect-risk classes.

A tree-to-dry grade mill study was made on second-growth ponderosa pine in cooperation with the Diamond Match Company at its Stirling City mill in order to obtain data on the value of trees and logs of different sizes found in the westside second-growth area. This area is of growing importance from a land-use point of view, and in it there has been intermittent but rather widespread cutting. Data on green lumber tally have been computed, and completion of the study awaits data on air-dry material, which will be taken this spring.

Completion of Part II, "Office procedure" of "Field and office procedures adapted to logging and milling studies in the California pine region" was further delayed by the resignation early in the year of Thomas J. Orr, co-author. Completion date is indefinite.

If a suitable mill can be found and the necessary co-operation obtained, it is planned to conduct a mill study in the redwood region to gather data needed in formulating log grades.

If opportunity offers it is planned to check the recommended standard log grades for ponderosa pine developed jointly last year by three Stations -- the Northern Rocky Mountain, the Pacific Northwest, and the California.

Utilization Problems

During the past year a general survey of some of the wood-using industries in the southern part of the State was made to determine the class of furniture and allied products being manufactured, kinds and qualities of wood being used, and particularly the extent to which local woods were used and the conditions controlling an increase in their use. Considerable quantities of softwoods -- redwood and pine -- produced within the State are being used in various types of furniture in combination with hardwoods and in special designs adapted to them. Manufacturers also use a wide variety of eastern and western hardwoods and imported hardwoods covering a range in quality which should include some of those growing in the State, but which are not now being cut on a commercial basis. Through the use of face veneers, the application of wood-grain reproductions carried on cellulose lacquer films, and skillful use of blended finishes, many combinations of woods are used in single pieces of furniture. In many cases cost seems to be the controlling factor in this highly competitive field. During the coming year it is planned to conduct a quantitative survey of sufficient intensity to give a good estimate of the market possibilities for local woods.

In the field of utilization of low-grade softwoods and such woods as white fir a number of box manufacturers interviewed reiterated the common complaint that white fir was prone to check and split in nailing and did not look as clean and attractive as pine. It was observed in some box plants that white fir was being made up into shook in a partly seasoned condition, and a considerable amount of checking was taking place in the storage rooms as the stock dried out. This emphasizes a serious factor in the white-fir utilization problem -- the fact that it is regarded as of low value not worth proper seasoning results in dissatisfaction with the fabricated product and reflects adversely upon the reputation of the wood.

During the year the Products Division has acted in an advisory capacity on utilization problems including several originating with other Government Departments interested in construction activities and the use of fabricated articles of wood.

FOREST SURVEY

The field mapping of the natural vegetation of California and western Nevada has covered 32 million acres out of the total 72 million acres. Such mapping of the natural vegetation has been an essential first step in the Forest Survey in this region because (1) the solution of fire hazard, flood control, and other acute wild-land management problems required data on all types of natural cover, and (2) the extent, location, condition, and potential timber-growing capacity of forest land were determined at the same time. These data comprised an important part of the forest resource data required and would facilitate the subsequent inventory of the quantity, species, quality, and current growth of the standing timber. Furthermore, the mapping of chaparral and woodland areas has had priority over the mapping of timbered areas where fire hazard and flood control problems were less acute.

Now, however, the situation has changed. Developments in aerial photographic surveys have made previous methods obsolescent. It is now possible to proceed directly to the timber volume inventory phase of the Forest Survey, it being no longer necessary to locate the forests first and classify their condition by costly field surveys. This essential information, as well as accurate base maps upon which to transpose it, can be obtained more satisfactorily directly from the air photographs. This is particularly fortunate because in view of National Defense needs and the forest program being undertaken by the Forest Service the timber volume inventory has now become of first importance. The need for further mapping of the natural vegetation is now less urgent because a broad yet useful classification of vegetation can be obtained directly from the photographs, and the pressing demands for more detailed information occur mainly in the regions already covered by field surveys. Furthermore, with the broad classification from air photographs as a start, the more detailed mapping of the vegetation can as advantageously follow the inventory as precede it.

Thus the current work of the Forest Survey Division, which has been oriented to meet the changed situation, falls under two broad headings, (1) timber inventory and (2) vegetation survey. Activities under the first represent mainly the development of a plan; under the second, the analysis and preparation of the data already collected for use in form of maps, reports, and publications.

Timber Inventory

That an inventory of the timber resource of California is urgently needed and should rank high in comparison with other regions is indicated by the following statistics. About one-fifth of the land area of the State is capable of supporting conifer timber and much of this land is of very high timber-growing capacity.

Although the estimated total sawtimber stand of 213 billion board feet is only 12 percent of the total in the United States, it represents 50 percent of that yet to be inventoried in the Nation-wide survey. The importance of an adequate inventory is further emphasized when it is considered that California is the No. 3 State in lumber production, being surpassed only by Oregon and Washington, which States have been already inventoried. The number of people supported by the lumber and woods industries totals 175,000, and the value of timber products produced annually averages about 46 million dollars. In planning for the stability of these industries and dependent communities, reliable information on the forest resource is basic.

The execution of the inventory plan now in preparation hinges upon the availability of both aerial photographs on a scale of not less than 1:20,000 and of inch-scale planimetric maps constructed from the same photographs. Thanks to the programs of the AAA, Flood Control Surveys, the Soil Conservation Service, and the Forest Service 42 percent of the 72 million acres included in vegetation type map project area has been flown to date and 13 percent more is proposed for 1941. Thus by the end of 1941 photographs will be available for over half of the required area. It is estimated that these photographs will cover more than 40 percent of the commercial timber area of the region. With this advance start it would seem that the flying program should keep well ahead of the needs of the inventory.

On the other hand, the more costly but equally essential planimetric map construction has lagged far behind the flying. The Forest Service, the only agency so far engaged in such work, has completed maps for 2.5 million acres on the Tahoe National Forest and vicinity and is now preparing similar maps for areas flown on the Eldorado and Mono National Forests. In addition it is proposing to fly and prepare maps for the Plumas National Forest in 1941. With the completion of the 1941 program both photographs and planimetric maps will be available for inventory purposes of a 9-million-acre section of the Sierra Nevada, embracing at least the timbered portions of 10 counties in California and 3 in Nevada.

Although planimetric map construction has not kept pace with flying, there is an encouraging interest in such maps by counties and other agencies. Several counties, for example, have cooperated in the current Forest Service program, contributing $1,000 each toward the construction of such maps. It is believed that many other counties will find the Forest Survey classifications so valuable for tax assessment purposes that they may be induced to pay for a large part if not the entire cost of planimetric maps outside the national forests. We are encouraged to believe this because of the interest already shown by those concerned with assessment problems. For example, the Survey Division has been invited to present its classification before a joint meeting of the Taxation Committee of the State Chamber of Commerce and a committee representing the State Association of County Assessors.

With this use of our data in mind we have under way the preparation of a report describing the techniques developed and presenting a series of sample maps illustrating their application in land classification to typical areas in the Sierra Nevada region. To test these classifications and also to provide supporting data as to their value, a two-man field crew was employed for a month's time in collecting sample plot data. The data are now being analyzed and the report, which will be multilithed, should serve two purposes: (1) as an aid in enlisting cooperation from State and county agencies in the planimetric base map program; and (2) as an integral part of the timber inventory plan. Work on the timber inventory plan, thus far delayed by urgent tasks, will then be pushed to completion.

Vegetation Survey

As in previous years, the vegetation type data have continued to find many users. Among the more important may be listed Flood Control Surveys in planning for upstream watershed management, the Soil Conservation Service in its survey of farm woodland areas, and the County Planning Commissions of Alameda and Contra Costa Counties in their planning activities. During the year the California Planning Board gave recognition to the value of the survey in its Statewide Mapping Plan presented to the Governor. This plan recommends completion of the vegetation survey along with eight other major surveys and map series "essential to the proper development of the resources of California". It also recommends a State appropriation of $10,000 annually over a 10-year period to facilitate both field and office work in the vegetation survey.

During the past year, the present skeleton Forest Survey staff has directed its efforts towards making available as much as possible of the vast amount of data accumulated in past field surveys. The principal accomplishments are:

1. Northern Sierra Nevada Land Use Study.—The first draft of a bulletin reporting on this study, for which the Survey Division has provided much of the basic data and in which it has participated as coauthor, was completed, has been reviewed, and is now undergoing revision.

2. Vegetation Type Map Publication. — During the year one quadrangle came off the press; three more were advanced several steps in the process of publication; and an additional two were prepared for publication.

3. New Series of Vegetation Type and Forest Condition Maps. — This new map series is designed to make a generalized form of the original map data available for use before publication, which as indicated under (2) above, is proceeding at a slow rate. These maps comprise inch scale 15-minute blue-line print units upon which the data are shown by symbol legend. However, provision is made for superimposing a color legend that makes the maps more readily

usable. The vegetation map presents simplified types each of which groups together related plant associations with fairly similar use or fire-hazard characteristics. In forested regions the vegetation map is supplemented by the forest condition map, which classifies forest land according to both stand condition and site index or timber-growing capacity.

During the year 239 15-minute planimetric base map units were drafted, and negatives for blue-line printing were prepared for 52 units of the vegetation map out of 239 required and for 38 units of the forest condition map out of 74 required. The base map construction and drafting was a contribution of the Regional Forester in recognition of the value of these maps in national forest administration. Several master sets are being hand-colored for Forest Service use. Uncolored blue-line prints are available to other agencies at actual cost of prints. Among the first users outside the Forest Service have been the Soil Conservation Service and the Southern Pacific Lines, both of which are acquiring complete sets of prints.

4. New Series of Tree and Shrub Distribution Maps. — These maps show the dominant and individual occurrence of trees and shrubs as compiled from the original field maps, sample plots, photograph location notes, and herbarium specimens. The data are presented on 15-minute planimetric base map units used for the vegetation type and forest condition maps described above. When completed the units for each important tree and shrub will be assembled in individual Atlas folios. In addition to the unit distribution maps, the folio will contain an herbarium specimen, selected photographs illustrating plant character and typical associations, an area table for each map unit listing the acreages and associated dominants of each distinct plant association in which the species occurs, and an index map showing the map units for which the data have been compiled.

These maps are being compiled by WPA personnel formerly engaged in mounting and cataloguing herbarium specimens collected by the field mappers. From past demands for distribution data of this kind many important uses are anticipated. Although the project is barely under way the distribution maps for Ceanothus cuneatus in the vicinity of the Tahoe National Forest are being used in a study of deer distribution, it having been found that deer populations in the winter and spring months are largely concentrated in areas where this species is dominant.

5. Forest Survey Releases. — It is anticipated that four such releases will be issued during 1941. One of these, "Vegetation types and forest conditions of Ormsby, Douglas, and southwestern Washoe Counties Nevada," is now ready for final review prior to multilithing; and the preliminary draft of a second, reporting on Los Angeles and San Bernardino Counties in southern California, has been completed.

FOREST ECONOMICS

There is growing recognition of the need for forest-economics research in order to analyze orthodox economic problems as well as to help appraise and interpret the considerable amount of forest and range biological research and management practices resulting therefrom. In accord with this trend, economics work at the California Station has for the first time been given full divisional status during the past year, and consequently work is just getting under way. Although the one-man staff must act largely as a subject-matter-specialist, work of the Division is two-fold, namely: (1) Service functions. There is a continual stream of requests for statistical and other economic information on the forests of California and for critical economic appraisal of going projects and proposed publications. Requests come from within the Station, the administrative branch of the Forest Service, other Federal agencies, State offices, and individuals. Preparation of statements for the Nation-wide forest program in cooperation with the California regional office of the Forest Service is one example of a recent service function. (2) Research functions. Studies in land utilization have been the principal past effort, but since these have now reached a stage of completion and also because of the great importance of national defense it is appropriate to reconsider the research program. Facilities are so restricted that it is extremely important to direct effort into channels where need is greatest and results may be most fruitful. Research functions are nearly always cooperative with either other Divisions of the Station or outside agencies. This is true because economic analyses often use biological and other data assembled by scientists in these other fields.

Economic and Social Problems Needing Research

Of the many problems demanding study, the outstanding ones in California are mentioned below, but not in order of priority, because establishment of priorities is a task still ahead. Where past work has helped to crystallize the problem, this is indicated.

Social Aspects of Forest Enterprises

1. Evaluation of non-commodity forest products. - The economic evaluation of intangibles such as the worth of forests for recreation, wildlife, and watershed protection, is one of the most difficult yet most pressing problems to confront foresters. It has been avoided because of its difficulty, the uncertainty of getting results, and the ease with which conclusions may be attacked, but until these factors are analyzed in California, the soundness of forest policies will continue to be a matter of individual judgment and conjecture.

2. Analysis of forest employment and forest communities. - For a stabilized economy it is necessary to know labor requirements, source of labor, workers' standard of living, and employer-employee relations. Comparison of company and non-company towns and of communities supported by liquidating and sustained-yield enterprises is essential for effective county planning in the Sierra foothills and other areas.

Interrelation Between Forestry and Other Enterprises

Land-utilization studies along the western Sierra Nevada foothills, conducted in cooperation with the Giannini Foundation, have emphasized outstanding specific problems requiring further detailed research, one of which is:

1. Relative income from forest or grazing use. - In the marginal tension zone of the foothill region this is a critical economic question which is closely related to the brush-burning and fire problems of the area. Such an investigation would require cooperation of the Forest Management, Fire, and Range Research Divisions of the Station.

Forest Industry Finance

1. All-risk forest protection insurance. - Mono-risk forest fire insurance has been found feasible for the Pacific Coast but is not being written. It is proposed to find out why by circularizing forest operators and insurance companies. Protection insurance, which would cover insects, windstorm, and perhaps disease, as well as fire, would be of greater service to the insured by eliminating more risk and thus allowing the total cost of protection to be budgeted as an annual expense. In one year insects alone not infrequently destroy five times as much timber as forest fires in California, and inadequate protection continues to be one main obstacle to the practice of private forestry. If found practical, protection insurance would fit into the Nation-wide forest program of increased cooperation in forest protection and might be one of the requirements for loans under a forest credits bank.

2. Costs and returns in producing second-growth timber. - In the foothill pine region a general analysis of factors affecting income has been made; a case study of a specific forest property such as an experimental forest is needed to investigate, for farmers and other operators of second-growth forests, the size of an economic unit, value of such secondary products as veneer bolts a nd piling, costs of different methods of protection and harvesting including road spacing, and the proper valuation of forest land and growing stock under different rotations and cutting cycles. Results would be of value in general forestry extension, but especially in forest farming and farm forestry. Cooperation of the Management, Survey, and Products Divisions of the Station would be required.

Marketing, Distribution, and Consumption of Forest Products

Problems of marketing are of intense concern to both large and small operators and will become more acute when stimulus of national-preparedness demand slacks off. Two major needs are:

1. Producer cooperatives for farmers and other small forest owners. - What adjustment in existing type of associations is needed to meet California conditions; would owners respond to the cooperative approach; how could they be financed and managed?

2. Competition and commodity analysis. - To determine for major and minor forest products the competition between species, between different parts of the State, and especially between the Pacific Northwest and California for markets in the latter State. The encroachment of forest products from the Northwest into California local markets revolves partly about transportation rate differentials. The market for white fir is still a vexing question in spite of past research.

Range Economics

Of the many problems in this practically untouched field, one of the most urgent is economic appraisal of range-management practices. It is necessary to know whether degree of utilization, season of use, systems of grazing, kind of livestock, and type of animal distribution that are most desirable from the range-ecology viewpoint will also yield the greatest economic returns. Can the costs involved in range revegetation, both natural and artificial, be justified socially and economically? There are the problems of range insurance, valuation of range lands for taxation and credit purposes, and many others. Studies in range economics would be cooperative with the Range Research Division of the Station.

Work in 1940

1. The study of "Land utilization in the northern Sierra Nevada foothills," conducted in cooperation with the Giannini Foundation of Agricultural Economics at the University of California, is nearing publication. Analysis of field data, assembly of maps, and preparation of all the text except the summary chapter have been completed. The manuscript has received several reviews and is now being polished. Salient results of this study are summarized in annual reports of the Station 1937-1939.

2. A study of "Factors affecting income from second-growth forests in the Sierra Nevada foothills" is reported on in the 1939 annual report. During the past year, a manuscript on this study has been prepared, criticized in the Washington office, and is now being revised.

3. "A survey of marketing conditions for west slope Sierra second-growth timber" was initiated and completed in 1940 and results were summarized in the December bi-monthly report. The record on this study provides a background for more intensive research, serves as a historical statement of a rapidly changing situation, and is of value to county farm advisors, forest farmers, and others interested in the second-growth resource. Three main conclusions are:

a. The trend in the use of second-growth lumber has been downward during the past few years and the prospect of developing a satisfactory outlet for second-growth lumber manufactured by small sawmills does not appear favorable. There are many handicaps such as poorly equipped mills, levelling off of the foothill mining boom with corresponding decreased demand, seasoning difficulties, hardness of the lumber, and its alleged tendency to split when used for box shook. There have also been recent declines in the demand for mine poles and fuel wood from the second-growth region.

b. Two secondary wood products, namely piling and veneer, show increasing production. The manufacture of box top veneer from second-growth timber has been slowly but steadily increasing since its beginning several years ago, and may be expected to continue increasing gradually if the use of veneer baskets gains wider acceptance. Production of piling from second-growth Douglas fir, ponderosa pine, and white fir in California is a recent and somewhat spectacular development that has attracted considerable attention. Stimulus for the demand comes mainly from national-defense construction projects in the San Francisco Bay area and consequently the piling market may decline somewhat after the construction peak is passed.

c. If present indications are borne out, operators of farm and small industrial forests can expect to find adequate lumber markets only by ignoring much of the second-growth for the time being and drawing mainly on old-growth timber. This is perhaps a desirable development because the second-growth, although now becoming merchantable, is not yet mature or ripe for harvesting. If properly selected, some products such as mine poles, fuel wood, and possibly veneer trees, may be taken from certain second-growth stands without detriment to the future volume or quality of saw-timber. Piling probably will continue to be taken as long as there is a demand, even though trees suited to this purpose would make good lumber if left to mature.

Work Planned in 1941

1. The study of "Land utilization in the northern Sierra Nevada foothills" will be completed in cooperation with the Giannini Foundation and published as an Agricultural Experiment Station bulletin.

2. The study of "Factors affecting income from second-growth forests in the Sierra Nevada foothills" will be completed by H. R. Josephson, who though no longer with the Station, plans to continue this analysis as part of his professional duties at the University of California. Plans are to finish revision of the manuscript and submit it for publication, probably as an Agricultural Experiment Station bulletin.

3. Priorities will be established for the economic and social problems needing research as outlined above, and work will be initiated on the problem given first choice. A regional forest economic problem analysis will be started after completion of exploratory research on the main problems.

FOREST AND RANGE INFLUENCES

The Division of Forest Influences, with little more than a decade of active experience in California, has been called upon to supply all the resources at its disposal to meet the urgent needs of the Departmental Flood Control Survey program in this State. This has been done, though it has meant sacrifices in the shifting of experienced personnel and the curtailment of some research projects. The Division has supplied data from its field installations in southern California and elsewhere that have been of great value in the preparation of Flood Control Survey reports. Material from the San Dimas Experimental Forest alone, which was used in the Los Angeles and San Gabriel River Flood Control Reports, included the following:

1. Maximum rainfall intensities for mountain areas.

2. Total rainfall for major storms.

3. Hydrographs for flood-producing rains of January, 1934, March 1938, and other major storms.

4. Data on concentration time of flood peaks in relation to rainfall intensities for watersheds of different size.

5. Seasonal stream-flow for several watersheds.

6. Rates of erosion from small and large watersheds in relation to age or density of vegetative cover and rainfall intensity.

7. Surface run-off and erosion data from plots, denuded or with different types of vegetation.

Although these data are only a small portion of what might be desired, they are early products of inestimable value already obtained from a large outdoor laboratory. Their pertinence and immediate use in Flood Control Surveys serve to justify the costly installations necessary to obtain them.

The Influences Division has contributed in other ways in the developing of watershed improvement plans for flood control, particularly with soil-stabilization techniques for burned areas, slides, and road slopes. Revegetation is the key to erosion control, but the means of obtaining a protective cover of this character are often difficult. Methods which have been proved successful and economically feasible through investigation by this Station include the sowing of mustard to produce a quick cover crop on mountain areas denuded by fire and contour wattling with planting of native vegetation for the stabilization of slides and road slopes. Improved road drainage and occasional masonry toe walls are essential adjuncts on many projects to provide satisfactory control of water and soil.

These measures, augmented by masonry channel stabilization barriers, were included in an experimental program of watershed rehabilitation following denudation by fire in the Fern Canyon area of the San Dimas Experimental Forest. Most of the work was completed during the past year and, while its effectiveness is already apparent, no storms of large magnitude have occurred since then to subject it to a major test.

The emphasis in watershed management in this region is still focused sharply on flood control. The principal long-range objective of research in forest influences, however, remains the improvement of water yield from mountain areas, and most of the investigations at San Dimas, Kings River, and North Fork are designed to solve water-supply problems. This objective will continue to receive the consideration it warrants, although public support can be expected to shift alternately from flood control to water conservation with the trend of climatic cycles.

VEGETATIVE COVER AND STREAM-FLOW

This Station has expended considerable effort during the past 7 years in planning and equipping the San Dimas Experimental Forest in southern California and the Kings River in the San Joaquin basin as outdoor laboratories to measure water yield from more than a score of large and small watersheds. Much data have been accumulated from these installations. Seasonal yields from watersheds in the chaparral type of southern California show wide variations from less than 1 percent to 25 percent of the annual rainfall. Corresponding figures from the Big Creek watersheds (woodland-grass type) in the lower Kings River drainage range from 3 percent to 30 percent of the seasonal precipitation. These records are valuable as end products of run-off from entire drainage units. However, the variations in yields of surface flow from the same watershed, season by season, and fluctuations in yields between similar watersheds indicate the necessity of detailed studies designed to isolate and evaluate separately the numerous factors which influence the end product. Knowledge of these factors is essential to efficient watershed management.

Detailed investigations of this character, using small plots, lysimeters, rainfall interception and stem-flow gages, and intensive soil-moisture sampling, have been in progress at North Fork in the Sierra Nevada foothills of the San Joaquin valley since 1929. The results of these studies for a 9-year period are indicative of certain important influences vegetation has upon the water cycle. For example, annual burning of the woodland-chaparral vegetation increased the seasonal run-off to nearly 40 percent of the precipitation, compared with 0.1 percent from undisturbed vegetation. During individual storms of high intensity surface run-off from annually burned plots often exceeded 50 percent of the rainfall, whereas flows from undisturbed plots never exceeded 0.5 percent of the rain.

Repeated burning of the vegetation on this area caused a 94-percent reduction in the infiltration capacity of the soil. As a result of this change, the proportion of rainfall contributing to surface run-off was increased more than 175 times, and the time during which precipitation produced surface run-off was lengthened more than 500 times.

Annual evaporation losses (interception, surface evaporation, and transpiration) from plots at North Fork with undisturbed vegetation averaged 19.6 inches, which was 1.77 inches more than evaporation from the burned areas. Percolation through a 48-inch soil profile under the vegetation averaged 26.18 inches or 8.54 inches more than that for the denuded areas. The average annual water yield (surface run-off plus percolation) from plots with vegetation undisturbed was 26.2 inches, or 1.8 inches less than from the annually burned areas.

These investigations have been reported upon in detail in a manuscript "Influences of woodland-chaparral vegetation on soil-water relations" by P. B. Rowe, which is now under Departmental review.

Similar run-off data have been obtained from plot studies in the chaparral region of southern California. Near Tanbark Flat on the San Dimas area, a series of 9 plots in vegetation undisturbed for 20 years has consistently yielded very low surface run-off, averaging less than 0.5 percent of the rainfall over a 5-year period, with a maximum of 2 percent during the major storm of March 1938. Surface run-off from a similar series of plots in Fern Canyon on the San Dimas Forest did not exceed 1 percent of the precipitation when protected by dense 50-year-old chaparral. Following denudation by fire in 1938, seasonal run-off from these plots increased to 5.3 percent of the precipitation, even though rainfall intensities were lower than had previously been experienced. The second year after the fire, run-off decreased to 1.2 percent, although the seasonal rainfall was 50 percent greater. This reduction in run-off was caused chiefly by a heavy growth of annual and perennial vegetation which developed on the area.

The significance of these studies lies in their production of quantitative evidence of the effects of vegetation upon soil-water relations. The results show that a natural cover of woodland-chaparral vegetation, by maintaining soil conditions favorable to the development of high infiltration capacities, reduces surface run-off and erosion. Vegetation thus reduces flash flood peaks, prolongs stream-flow at lower stages, and maintains the purity of run-off waters by reducing their silt content. It should be emphasized that the large percentage of run-off waters which percolate through the soil mass under forest cover is not all lost through transpiration, but that a great part of it escapes by seepage through springs and regulated stream-flow. On the other hand, the large volumes of surface run-off from fire-denuded areas

are generally so laden with eroded material that they are not only useless for direct consumption but cause damage downstream by sedimentation in low gradient channels, reservoirs and spreading works. The total yield of water from covered and burned plots appears nearly equal, but the net result, in terms of high quality directly useful water, is all in favor of an undisturbed cover of vegetation on watershed lands.

Plot studies in second-growth ponderosa pine at Bass Lake, near North Fork, are being augmented by detailed interception and soil-moisture observations. Work of this character at the North Fork installation will be limited to certain plots upon which artificial rain can be applied. Treatment of the vegetation on the Tanbark Flat plots at San Dimas has been delayed pending the opportunity to start corollary interception determinations. This is planned for the coming year. Periodic soil-moisture sampling has been started at the Tanbark and Fern plots and at five locations in Watershed Ten (Monroe) on the San Dimas Forest as a preliminary study. These observations will be extended next year, if personnel permits, to supplement stream-flow records from other watersheds.

An infiltration study, employing the North Fork infiltrometer to determine the influence of different intensities of grazing on the infiltration capacity of the soil, was made on the 1/40-acre surface run-off and erosion plots of the San Joaquin Experimental Range in cooperation with the Division of Range Management. Results of 54 determinations made on the 9 plots indicate that grazing, moderate as well as heavy, reduced the infiltration capacities of the soil. It is of interest, however, that the infiltration capacities of both grazed plots still remained greater than the usual maximum rainfall intensities of the region. Natural rains on the plots produced no significant amounts of surface run-off. The water yield from the plots was not as overland flow, but as seepage through the soil.

VEGETATIVE COVER AND EROSION

The influence of vegetation in the control of erosion on mountain watersheds is becoming fairly well defined for certain important cover types in this region based upon measurements made from a number of watersheds and many plots. Excessive erosion appears as a function of increased run-off where the vegetative cover has been removed. This run-off might appear to be a good thing in augmenting supplies of stored water, whether in reservoirs or sunk in alluvial gravel beds, but the accompanying debris load proves a serious detriment by occupying valuable storage space in reservoirs and rendering water-spreading grounds inefficient through loss in percolating capacity. Furthermore, the bulking of flood run-off with debris may destroy valuable agricultural lands and improvements and result in loss of life.

The southern California chaparral region has supplied numerous instances of the acceleration of erosion after the vegetation cover has been destroyed. A fire in November 1933 destroyed the cover on 5,000 acres of mountain watershed in the Verdugo drainage north of Glendale. Measurements taken by the Los Angeles County Flood Control District following the violent 12-inch storm of New Year's Day 1934 showed that erosion took place at the rate of 75,000 to 125,000 cubic yards per square mile from a representative part of the burned area. Measurements during the same storm in small watersheds of Fern Canyon on the San Dimas Experimental Forest with dense cover of chaparral indicated but a trace of erosion. Some 4 years later in March 1938 another heavy storm which produced from 17 to 23 inches of precipitation on the Verdugo area again produced erosion at the rate of 60,000 to 125,000 cubic yards per square mile. During this storm the Bell and Fern watersheds on the San Dimas Experimental Forest yielded erosion amounting to 20,000 cubic yards per square mile from the former where the cover was 19 years old, and only 2,000 to 5,000 yards per square mile from the Fern watersheds with 50-year-old cover. Debris in the latter instance resulted principally from the scouring out of accumulated debris in channels.

In November 1938 the Fern watersheds were denuded by a serious brush fire and a month later were subjected to a storm of about half the size in total precipitation of that in March 1938. Erosion at the rate of 5,000 cubic yards per square mile was measured, most of it coming from the slopes.

These erosion rates for entire watersheds have been checked by observations made on small plots adjacent to both the Bell and Fern areas and covered with similar vegetation. In 1934 there was but a trace of erosion, likewise in March 1938, but after the fire of November 1938 the Fern plots, having been very thoroughly denuded, showed a total seasonal debris movement of 2,000 cubic feet per acre. The Tanbark plots, still undisturbed, produced 2 cubic feet per acre. During the season 1939-40, the rainfall was 50 percent greater than 1938-39, but rapid recovery of vegetation on the Fern plots reduced the amount of erosion to 145 cubic feet per acre. The Tanbark plots with undisturbed cover continued to show negligible erosion.

At North Fork in the San Joaquin foothills, intensive plot studies have been under way for several years. Here again experimentation proves the value of a vegetative cover. Plots denuded annually by fire produced erosion at the rate of 113 tons per acre during a 9-year period. Plots burned but twice showed 4 tons per acre, compared with 0.006 ton per acre from areas with natural woodland-chaparral cover. This latter rate may be considered negligible.

Studies planned for the future are designed to interpret these and subsequent findings in terms of improved watershed management.

INTERAGENCY FLOOD CONTROL SURVEYS

Outstanding feature of the Flood Control Surveys in California was the final approval of the report on the Los Angeles River. The necessary agreements, covering an initial action program of $1,450,000, have been signed by all cooperating agencies, and actual work on the project is expected to start at an early date.

Flood control surveys in this region have continued under Coordinating Committees 18 and 20, representing the Forest Service, the Soil Conservation Service, and the Bureau of Agricultural Economics. The State Flood Control Committee continued its cooperation with the Department through the State Engineer and specialists of the University of California.

PRELIMINARY EXAMINATIONS

The Department has participated with the Corps of Engineers, United States Army, in a total of 32 hearings on 32 streams or groups of streams since the spring of 1937, when flood control investigations were authorized.

Two preliminary examination reports were forwarded to Washington during 1940, reporting on 4,830 square miles of watershed area, including the Santa Ynez River watershed and the Walker River watershed.

SURVEY WORK OUTLINES

The preparation of survey work outlines was authorized in 1939 for six watershed groups distributed throughout the State and embracing 27,700 square miles. Outlines for four of these watersheds, the Pajaro, containing 1,300 square miles; the Kings-Kaweah-Tule-Kern group of 12,150 square miles; the Santa Maria of 1,875 square miles; and the Santa Ana, 2,500 square miles, have been completed and forwarded to Washington. Survey work outline for the Salinas River watershed has been completed and is being reviewed, and will be forwarded to Washington by the end of February 1941. Preliminary work on the Upper Sacramento River survey work outline has been accomplished but completion has been deferred until certain data regarding flood damage and siltation of reservoirs have been obtained. This will be accomplished when the watershed area is accessible in the early spring.

DETAILED SURVEY REPORTS

The first survey report by Field Coordinating Committee 18, on the Los Angeles River watershed, which was completed and submitted to Washington in October 1939, was approved and authorization for action program received. This program, which is the first approved under the 1936 Omnibus Flood Control Act, will be initiated early in 1941.

Survey work on the San Gabriel River watershed has been completed and report submitted to the Field Work Committee for review. The report will be forwarded to Washington early in 1941.

Survey work on the Santa Ana and Santa Maria Surveys was initiated in September and November, respectively, and is progressing satisfactorily, with the Santa Ana 25 percent complete and the Santa Maria 20 percent complete. The Pajaro Survey, started in January 1940, is now 85 percent complete and report will be submitted by March or April 1941.

Two temporary stream-gaging stations and eight rain gages were installed in the Santa Maria River watershed. During November and December 150 infiltrometer runs were made for five land-use classes, using "F" and "FA" North Fork infiltrometers.

Operation and maintenance of the 15 intensity-recording rain gages installed on the Santa Ana River watershed were continued by the Flood Control Survey organization to supplement with at least two winter's records the limited precipitation data in this watershed.

Cooperation with the Hydrologic Section of the U. S. Weather Bureau in establishing a primary network of precipitation stations throughout the State was continued during the year.

LIBRARY AND STATISTICAL SECTION

Progress reported upon by the several Divisions in the preceding pages has been facilitated in noteworthy fashion by the special services of these two sections.

The functions and services of the Station library, under the direction of Annie M. Avakian, include: selective acquisition of books and pamphlets needed as handy research tools, preparation and maintenance of mailing lists and distribution of publications, circulation of material for staff reading, translations (French, German, Spanish, and Russian), and assembly of specific subject matter for lectures and manuscripts.

The statistical section, under the direction of Kathleen G. Brecheen, aided by a staff of emergency computers, handles statistical analyses as requested by the various Divisions. These services, which also save much division-staff time, include both routine calculations and advisory work relating to new trends in methodology and design.

LIBRARY COPY
ROCKY MT. FOREST & RANGE
EXPERIMENT STATION

COOPERATING AGENCIES

COOPERATIVE STUDIES WITH ANIMAL HUSBANDRY DIVISION UNIVERSITY OF CALIFORNIA

This series of highly important and practical studies and experiments in range animal husbandry, an integral part of the cooperative range program at the San Joaquin Experimental Range, was continued during the year without major changes, under the direction of G. H. Hart (Head of the Division), H. R. Guilbert (Associate Animal Husbandman), and Kenneth Wagnon (resident animal husbandman, San Joaquin Experimental Range). Preliminary analysis of data through 1939 was completed and the most significant findings were incorporated in the manuscript of an interagency progress report covering the entire program. This manuscript is now in the hands of the University board of review. It is intended as a University bulletin and should be in press within a few weeks.

COOPERATIVE STUDIES WITH BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

(Statement submitted by J. M. Miller, Senior Entomologist, K. A. Salman, Entomologist)

The program of the Berkeley Laboratory of the Bureau of Entomology and Plant Quarantine is closely associated in several of its phases with that of the California Forest and Range Experiment Station. Joint efforts by personnel from both organizations are proceeding satisfactorily toward the solution of several forest-management problems in which entomological factors are important. In addition, the two organizations have cooperated on special problems in forest products, forest insect surveys, influences, and forest genetics.

Blacks Mountain Sanitation Salvage Logging

Another year's results on tests of bark-beetle control by the use of a highly selective sanitation logging of high-risk trees are available to show the degree of control secured. For the 3-year period during which work has been going on, losses on treated areas have been reduced to but 23 percent of those in adjacent and comparable untreated stands. Control work on some of the individual treated compartments in the Blacks Mountain Experimental Forest has given even better results for shorter periods of time. In several instances reductions in loss amounted to as much as 80 or even 90 percent of the loss on untreated areas.

The criteria being used to determine the susceptibility or risk of individual trees to bark-beetle attacks continue to yield satisfactory results in application to marking. For the 3 years of record, 83 percent of the total loss has occurred in the 12 percent of the stand which was originally classified as being in high-risk trees. Work on the Blacks Mountain project will continue in the same way in order to determine how long after treatment the control effects will continue to be exhibited on treated areas, as well as to further the study of risk and infestation relationships in treated and untreated stands.

Plantation Problems

Preliminary tests were made on the control of Cylindrocopturus eatoni Buchanan, a small weevil which has been killing 6- and 7-year-old planted stock in the Big Springs Plantation. Experiments with potted seedlings and in the plantation indicated that the use of concentrated sprays containing lead arsenate effectively prevented damage to trees exposed to attack by the weevil.

Experimental work on the control of the resin midge in the ponderosa pine plantations at the Institute of Forest Genetics was

continued. In May some of the more promising formulae for sprays developed and tested in previous work proved effective in controlling a heavy resin midge infestation in the progeny block.

Hazard Inventory

In September 1940 field work in the Tahoe National Forest completed the 4-year program of the insect hazard inventory project, one of the most comprehensive forest insect-survey projects ever undertaken in California. The area was the last to be surveyed in a program which included the sampling of forest insect hazard on nearly two and a half million timbered acres, but it was the first area on which Forest Service aerial photographs were available for use in the field work. Compilations and analyses of the field data gathered by field crews during the past season are now being made. The final report, which is expected to appear soon, will supplement detailed reports on smaller unit areas.

Scale Insects

Because of the important role some species of the scale genus Matsucoccus may play in the insect complex concerned in the death of ponderosa pines, series of uninfested pine poles were artificially infested and infestations on heavily infested poles were sprayed to determine the effect on trees of the presence of or reduction in populations of Matsucoccus.

Observations in southern California indicate that pine needle scales may be injurious to infested trees in some areas. Experiments have been planned to test artificial control of existing infestations by the use of oil sprays during the winter period.

Sierra Studies

Studies of climatic factors and their relation to the amount and variations in seasonal forest-insect activities were continued at the Hat Creek Laboratory in the Burney area of the Lassen Forest. In addition, new studies were initiated this season near Miami on the Sierra Forest. The detailed climatic factor records being collected by the California Forest and Range Experiment Station at North Fork will be used as master records for comparison with those obtained from less complete field installations made at selected sites during this past season. This project is concerned not only with forest-insect activities in ponderosa pine, but with those in sugar pine as well.

In addition to the study of climatic factors and their relation to sugar pine losses, the characteristics of susceptible sugar pine trees are being examined carefully to determine if a method can be developed for rating the susceptibility of individual sugar pine trees to the attacks of the mountain pine beetle.

COOPERATIVE STUDIES WITH FISH AND WILDLIFE SERVICE DEPARTMENT OF THE INTERIOR

(Statement submitted by E. E. Horn, Biologist)

Studies to determine the relationship of wildlife to forest and range problems were continued in cooperation with the Station and the Regional Office. Many phases of these studies also include cooperation with the California Division of Fish and Game.

Wildlife Related to Pine Regeneration

Annual checks were made of the rabbit-damaged pine plantations of northern California, and all data are being summarized to show rates of growth of damaged and nondamaged trees. Survival on heavily damaged plantations continues to be very low.

The problem of control of seed-eaters and clipping animals was aided by the assignment of one man from Control Methods Research Laboratory at Denver to work on these problems. His headquarters are Mt. Shasta. Probably another worker on the ecological relationship phases can be assigned by July 1, 1941.

Wildlife Range Relationships

Intensive studies continued, with increased assistance on the field work. Study of the food habits of predatory animals and predacious birds indicate that coyotes on these areas feed heavily on ground squirrels and that hawk and owl food consists largely of rodents and reptiles.

Populations of wildlife of all the kinds studied fluctuate markedly over a period of years. There has been a steady decrease in numbers of quail and ground squirrels until they are now at the lowest point since the start of this study. Kangaroo rats are slowly increasing in number from their low of 1937. There are now about 5 rats per acre on the Range. The cottontail population increased from 1935 to 1938 and appeared to remain stationary until the summer of 1940, when a decline to about half the number occurred. Rattlesnakes are present in surprising numbers (though these numbers may be the usual population) of about 1.5 per acre. These snakes feed upon rodents and may exert some influence along with all other factors in limiting some of the rodent populations.

Studies of the effect of rodents upon the range continued in the enclosures, exclosures, and open range. Methods of rapid census of squirrels and kangaroo rats have been developed and assist in more accurate evaluation of rodent pressure on the range.

Wildlife Soils Relationship

A research project to determine the effect of wildlife on soils, erosion, run-off, and range breakdown was started in January 1940 at the Trimmer Springs Branch Station. The first year's work is largely exploratory. Species of animals present indicated that pocket gophers and ground squirrels are the most important vertebrates. Representative soil breaks have been examined and mapped. Activity of the gophers and the volume and weight of soil moved in their burrowing activities were studied. Efforts have been made to measure any effect of rodent burrowing upon soil moisture and fertility. Some small dams and water-measuring devices have been set up to measure water and silt run-off from small watersheds with varying populations of gophers.

Wildlife Disease Research

An intensive study of the diseases of certain California wildlife was started on August 1, 1940, and includes (1) the incidence of bird malaria (Haemoproteus) in quail, doves, and other birds, (2) coccidia in birds, rabbits, and rodents, (3) ulcerative enteritis in quail and other birds, (4) a preliminary but intensive study of the diseases or parasites associated with the fluctuation of rodent populations on the San Joaquin Range.

Wildlife Bibliography

An annotated bibliography on wildlife as related to forestry is in preparation for publication. About 5,000 abstracts have been prepared.

Cooperation - Game Management

Cooperation has been maintained with the California Fish and Game Division and the Regional Office of the Forest Service on the Mono Basin Deer Management Study, the Quail Management Study, and other activities on which our several services overlap.

INTERAGENCY QUAIL MANAGEMENT STUDY

(Statement submitted by E. E. Horn, Chairman, five-agency committee)

The quail study continued throughout the year with some changes in personnel and program. Ben Glading accepted the position of Junior Economic Biologist with the California Division of Fish and Game as project leader of the Quail Management Project under Federal Aid, effective August 1, 1940 — an excellent opportunity to apply many past findings to actual management. William H. Sholes, Jr., was assigned to the Range study by the California Division of Fish and Game to assist Glading and to continue the study after Glading's departure. Sholes continued until early December, when he was appointed Game Warden and moved to his new assignment. No successor to Glading had been selected by January 15.

The nesting study data need complete analysis to determine the degree of similarity of areas and conditions under which the studies were made. The 1940 season shows more nests recorded as destroyed by snakes. This may indicate a greater recognition of snake damage, rather than an actual increase in such depredation. Squirrel damage was less, but many of the nests studied were on the natural area of less than 100 acres, which has a very low squirrel population.

Numbers of quail on the entire Range have dropped consistently since the start of the study in 1937. A new low of one to 4 acres was recorded in the February 1940 census. The cause of this decline is not established, but disease and the water relationship are suspected as contributing factors. The nearly equal ratio of adult to young birds early in the fall indicates an enormous loss of young during the summer. Juvenile wildlife loss is a serious factor in maintaining a high level of populations. Determination of the cause of such losses and the steps necessary to eliminate them will be of much value.

The Fish and Wildlife Service opened a disease research project August 1, 1940, and an intensive study of diseases and parasites of the wildlife on the Range is under way. Quail are being considered in this study. Haemoproteus has been found in all quail examined by Glading in the past. Ten birds taken during October 1940 were heavily infested with coccidia, as well as Haemoproteus. Present studies include a systematic sampling of quail and doves from California to determine the incidence of Haemoproteus, coccidia, and any other suspected parasites or bacteria.

The experimental hunt continued in 1940, with an attempt to remove about 25 percent of the birds. While the prehunt census showed a lower population than secured on the area in past years, it

was about equal to other portions of the Range. About 70 birds were to be taken this season.

During October the General Committee met under chairmanship of T. I. Storer, University of California, reviewed the past work, and drew up suggestions for the future conduct of the study. The old Technical Committee was abandoned, and a five-man committee composed of one member from each agency was substituted for it. The General Committee continues its regular functions. In order to facilitate conduct of the study, one committee member was made responsible for immediate supervision of the research program and will act as chairman of the committee.

Staff Publications

Printed

Bermel, K. J. and R. W. Davenport
Transient flood peaks. American society of civil engineers. Proceedings 66(5):995-1002. May 1940. (This paper is a discussion of the article Transient flood peaks, by Henry B. Lynch, which was issued in American society of civil engineers. Proceedings 65(9):1605-1624. November 1939)

Biswell, H. H.
Subterranean clover growing well at the San Joaquin experimental range. California wool grower 16(39):4-5. September 24, 1940.

Bruce, H. D.
White arsenic to sterilize soil. Pacific rural press 140(13): 401. December 28, 1940.

Curry, J. R. and W. L. Fons
Forest-fire behavior studies. Mechanical engineering 62(3):219-225. March 1940.

Curry, J. R., L. G. Gray and I. C. Funk.
Forest fire-danger rating and its application in California. Journal of forestry 38(11):855-866. November 1940.

Fons, W. L.
An Eiffel type wind tunnel for forest research. Journal of forestry 38(11):881-884. November 1940.

———
Influence of forest cover on wind velocity. Journal of forestry 38(6):481-486. June 1940.

Fowells, H. A.
Cutworm damage to seedlings in California pine stands. Journal of forestry 38(7):590-591. July 1940.

Glading, Ben, H. H. Biswell and C. F. Smith
Studies on the food of the California quail in 1937. Journal of wildlife management 4(2):128-144. April 1940.

Hamilton, E. L.
San Dimas experimental forest. Southern California social studies review 16(5):10,12-14. October 1940.

Hormay, A. L.
The effect of logging on forage. Chronica botanica 6(1):6-7. October 7, 1940.

Jensen, H. A.
(Review of) Vegetation type maps of California and western Nevada. Journal of forestry 38(6):522-523. June 1940.

_____
Vegetation type maps of California and western Nevada. Science 92(2389):333. October 11, 1940.

_____
Conservation of the native flora (chapter in California's natural wealth - a conservation guide for secondary schools). Calif. State Dept. Education Bull. 9(4). December 1940.

Kotok, E. I.
The forester's dependence on the science of meteorology. American meteorological society. Bulletin 21(9):383-384. November 1940. (To be continued in December issue)

Kraebel, C. J. and J. D. Sinclair
The San Dimas experimental forest. American geophysical union. Transactions, 1940, v.1, p.84-92.

Mirov, N. T.
Tested methods of grafting pines. Journal of forestry 38(10):768-777. October 1940.

_____, translator
The geographic-complex method for the study of climate, by I. K. Tihomirov. Monthly weather review 68(8):214-216. August 1940.

Rowe, P. B.
The construction, operation, and use of the North Fork infiltrometer. (Oakland, Calif.) U. S. Dept. of agriculture, 1940. 64 p. (U.S.D.A. Flood control coordinating committee. Miscellaneous publication no. 1, and U. S. Forest service. California forest and range experiment station. Miscellaneous publication no. 1)

_____
The North Fork infiltrometer, an instrument for measuring the infiltration capacities of soils. Journal of forestry 38(?):588-589. July 1940.

Schreiber, B. O.
The Arctostaphylos canescens complex. American midland naturalist 23(3):617-632. May 1940.

_____
Vegetation type map herbarium. Chronica botanica 6(1):19. October 7, 1940.

Stockwell, W. P.
A revision of the genus Chaenactis. Stanford University, Calif., 1940. p.89-168. (Leland Stanford junior university. Dudley herbarium. Contributions, vol. 3, pt. 4)

Wieslander, A. E.
Vegetation survey and type map of California and western Nevada. Chronica botanica 6(7):160-161. Dec. 30, 1940.

Mimeographed

Abell, C. A.
Rates of initial spread of free-burning fires on the national forests of California. Berkeley, Calif., 1940. 26 p. (U.S. Forest service. California forest and range experiment station. Research note no. 24)

Dunning, Duncan
Direct seeding experiments in California. In Huberman, M. A., ed. Experimental direct seeding by the Forest service. Washington, D.C., 1940. p.18-24.

Gruenewald, F. A.
Preliminary statement on production of lumber and other timber products in California, 1939. Berkeley, Calif., 1940. 2 p. (U. S. Forest service. California forest and range experiment station. Technical note no. 13)

Hallin, William
Preliminary Port Orford cedar taper and volume tables. Berkeley, Calif., 1940. 10 p.

Hormay, A. L.
Palatabilities of foothill range plants for cattle. Berkeley, Calif., 1940. 4 p. (U. S. Forest service. California forest and range experiment station. Research note no. 25)

Kraebel, C. J.
Reduction in debris load through soil conservation and watershed management. In U. S. National resources planning board. Proceedings, meeting of the southern California coastal drainage basin committee, Los Angeles, Oct. 10, 1940. p.20-23.

Mirov, N. T.
Additional data on collecting and propagating the seeds of California wild plants. Berkeley, Calif., 1940. 17 p. (U. S. Forest service. California forest and range experiment station. Research note no. 21)

U. S. Forest Service. California forest and range experiment station. The forest problems of California. Berkeley, 1940. 27 p.

_____ Application of the forest program to problems of the Sierra Nevada foothills. Berkeley, 1940. 5 p.

_____ Jointly with the Northern Rocky Mountain and Pacific Northwest Forest and Range Experiment Stations. Ponderosa pine log grades. Berkeley. December 1939.

PROJECT STATUS SHEETS

RS-CAL
MENSURATION
Tree studies

January 1941

Tree Studies

1. Field division — Forest Management Research - Pine Region.

2. Work project — Mensuration.

3. Line project — Tree studies.

4. Purpose — To provide an adequate series of volume tables for six commercial species.

5. Review of past work — Many thousand tree measurements made between 1905 and 1936 by Region 5, State Board of Forestry, the University of California, and this Station. Of many tables prepared 88 still useful, of which 36 prepared by this Station. Current assistance in checking and application of tables.

6. Accomplishments during past year — None.

7. Plans for next year — None.

8. Date of completion — Checking and revision to continue indefinitely. About 15 modern old growth tables should be prepared.

9. Assignment — Dunning, Clements.

R5-CAL
REGENERATION

January 1941

Planting, Seeding and Nursery Practices

1. Field division — Forest Management Research - Pine Region.

2. Work project — Regeneration.

3. Line project — Planting, seeding, and nursery practices.

4. Purpose — To determine methods of reforesting burns and brushfields on timber sites.

5. Review of past work — Practical experiments in direct seeding between 1908 and 1913 mostly unsuccessful. Data on seed collection, storage, sowing and viability accumulated at Converse, Pilgrim Creek, Feather River, and Durbin Nurseries by Region 5 and Research 1911 to date. Technic of planting stock production developed by Region 5 and Research 1911 to 1920. Numerous planting tests made between 1911 and 1920. Results to 1920 reported by S. B. Show in U.S.D.A. Circ. 92.

Between 1929 and 1937, 15 seeding and 16 planting experiments on limited scale by Research.

In 1937, spring and fall experiments begun to compare survival and growth of ponderosa and Jeffrey pine seed-spots and transplants after three types of brush eradication, and effects of spraying trees with rabbit poison. Second year results for spring 1937 plantation reported.

In 1938, seed grade and stock grade study, and season of planting, method of storage study begun at Feather River.

6. Accomplishments during past year — Fourth season records for 1937 spring plantations completed and reports partly prepared. Third season field records for 1937 fall experiments made and report prepared.

Seed grade and stock grade study carried through the transplant phase.

Season of planting - method of storage study field records closed and final report being prepared.

International Union of Forest Research Organizations Scotch pine study carried through seedling stage.

Study of time of lifting - period of storage - method of storage of stock begun at Feather River in fall 1940.

Feather River nursery transplant production was 25,000; seedlings ready for transplanting total 61,000; seed sown to produce 45,000 seedlings; seed collected for three or four years requirements; soil renewed in ten transplant beds.

7. Plans for next year — Continue short term studies now in progress and prepare a memorandum of findings for guidance of Region 5. Prepare a brief article for publication including fourth year results of 1937 brushfield experiments at Burney Spring. Continue Feather River nursery production.

8. Date of completion — Continuing short-term studies.

9. Assignment — Dunning, Fowells, Morrow.

RS-CAL
SILVICULTURE
Harvest cuttings
Redwood

January 1941

Harvest Cuttings - Natural Regeneration and Yield as Affected by Cutting Methods and Slash Disposal

1. Field division — Forest Management Research - Redwood Region.

2. Work project — Silviculture.

3. Line project — Harvest cuttings - natural regeneration and yield as affected by cutting methods and slash disposal.

4. Purpose — To determine the best methods for converting virgin redwood stands to managed stands with maximum sustained yield.

5. Review of past work — It has been demonstrated that natural reproduction is most readily obtained on selectively cut areas; that steam logging (particularly with slackline) and broadcast burning are destructive of the currently unmerchantable part of the stand, including trees 30 or more inches in diameter, and create conditions unfavorable for regeneration, either artificial or natural; that small flexible yarding equipment (such as tractors) are best adapted to selective logging and are more efficient than steam under most redwood conditions, and that slash on selectively logged areas can be largely disposed of by controlled burning without serious crown damage to residual trees. Basal damage can be greatly reduced by preventing slash accumulation about residual trees during logging. Henry Creek study indicates minimum economic diameter limit of 36 to 40 inches, leaving reserve of 30 M to 40 M per acre, natural regeneration generally adequate but heaviest following medium to heavy slash burn. Mendocino County logging studies show sharp rise in costs for felling, peeling and yarding with decrease in tree diameter below 56 inches. Bucking and transportation costs little affected by tree diameter. 1,000 cores from 400 redwoods which had been left 10 to 50 years since logging were taken as the initial step in a study of increment of residual redwoods. A problem analysis for silvicultural investigation in the redwood region has been submitted.

6. Accomplishments during past year — Fifth year examination of Henry Creek reproduction quadrats and analysis of increment core data for study of increment of residual trees completed. The Yurok Experimental Forest for the northern redwood area was established. Discussions on the forest with Haig, Dunning and Hasel led to the conclusion that studies in methods of converting the virgin forest to managed stands should have first priority. The manuscript "Possibilities in the regeneration of redwood cut-over lands" was discussed with Haig and it was decided that it should be reorganized and some progress has been made in the revision.

7. Plans for next year — Completion of manuscript covering extensive study of natural reproduction on redwood cut-over lands. Detailed analysis of Henry Creek reproduction data and preparation of manuscript. A redwood tree classification, needed as a guide in tree marking, and work plans for initial studies on the experimental forest to be undertaken. Cooperation with Products on redwood logging and milling study if arrangements can be completed. Arcata thinning plots will be remeasured. Report and manuscript to be prepared on increment of residual redwoods.

8. Date of completion — Indefinite.

9. Assignment — Person, Hallin.

RS-CAL
MENSURATION
Tree studies
Volume tables-Redwood

January 1941

Tree Studies - Redwood and Port Orford Cedar Volume and Taper Tables

1. Field division — Forest Management Research - Redwood Region.

2. Work project — Mensuration.

3. Line project — Tree studies - redwood and Port Orford cedar volume and taper tables.

4. Purpose — Preparation of volume and taper tables for redwood and Port Orford cedar.

5. Review of past work — Study of available tables and methods applicable to redwoods begun in 1935. Measurements taken on 850 trees 1935-38. Redwood volume tables prepared for 5 top diameter-basal diameter ratios; 50, 60, 70, 80 and 90 percent of diameter i.b. at 20 feet above base. Schumacher logarithmic method used. Applicability of these tables to different areas checked by use of all collected data and data loaned by Pacific Lumber Company and Professor Fritz. Preliminary Port Orford cedar volume and taper tables prepared from measurements on 80 trees.

6. Accomplishments during past year — Two redwood taper tables were prepared for portion of tree below 12-inch top by use of regressions using percents of diameter and heights. Two volume tables prepared from taper tables.

7. Plans for next year — All the redwood volume and taper tables, and explanation of use and construction will be mimeographed in one station release in February or March.

8. Date of completion — 1941

9. Assignment — Hallin.

RS-CAL
REGENERATION
Planting
Redwood

January 1941

Planting - Establishment and Growth of Planted Redwood

1. Field division — Forest Management Research - Redwood Region.

2. Work project — Regeneration.

3. Line project — Planting - establishment and growth of planted redwood.

4. Purpose — To study methods and results of planting redwood and associated species.

5. Review of past work — Results of commercial planting on 26,400 acres of redwood cut-over show average early survival of 36 percent varied widely with exposure, interval between logging and planting, and associated vegetation. Poor survival and growth, especially on southerly exposures, found on clear-cut, severely burned areas. Recent damage and growth studies based on data from 1300 trees on 96 plots show sustained loss of planted trees principally from fire and rodents. Average growth for 10 to 15-year-old trees .54 feet per year.

6. Accomplishments during past year — The 96 plots established 1937 reexamined and preliminary analysis of records made. After 10 to 15 years of very slow average growth rate trees now showing marked acceleration of growth. Annual average height growth from time of planting (1925 to 1930) to 1937 only .53 feet. Average annual growth for period 1937 to 1940 .87 ft.

7. Plans for next year — The data from 1937, 1938 and 1940 examinations will be studied using analysis of variance and the results prepared for publication.

8. Date of completion — Indefinite.

9. Assignment — Person, Hallin.

RS-CAL
FIRE
Behavior
Forest Fuels

January 1941

Behavior - Forest Fuels

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Behavior - forest fuels.

4. Purpose — To establish a valid basis for classifying fuel types as they affect fire control practices by (1) ascertaining the pertinent variables which define the characteristics of forest fuels as they affect fire behavior and (2) providing a practical method for measuring or estimating the magnitude of the variables.

5. Review of past work — Started in 1935 primarily to determine expressions defining fuel and fuel bed characteristics and to investigate their influences on rate of spread in needle litter fuels. Laboratory scale studies in a wind tunnel since have shown that variations in rate of spread of surface litter fires can be correlated with wind, fuel moisture, and the fuel and fuel bed variables, fineness or surface-volume ratio, and compactness or the ratio of voids to fuel surface area in a fuel bed, respectively. Progress reports have been prepared annually.

6. Accomplishments during past year — A technique for burning miniature brush twig fires in the wind tunnel was developed. Data obtained on these fires have been summarized but not yet analyzed.

7. Plans for next year — Continue to obtain data on brush twigs and on broadleaf fuels to determine the validity of the present forest fuel variable measures in defining fuel and fuel bed characteristics.

8. Date of completion — Indefinite.

9. Assignment — Fons.

RS-CAL
FIRE
Behavior
Fuel moisture content

January 1941

Behavior - Fuel Moisture Content

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Behavior - fuel moisture content.

4. Purpose — To determine methods of sampling and measuring moisture contents of litter and green fuels, the causes of their variations and correlation with weather, insolation and other factors.

5. Review of past work — Study of sampling and moisture determination methods for ponderosa pine litter and northern California brush fuels started in 1935. Satisfactory sampling and determination methods developed. Seasonal variations in moisture content and volume of foliage of northern California brush species studied 1937 through 1939. Significant variations influencing fire behavior found to occur during seven-month season from April to November.

6. Accomplishments during past year — Continued study of weather and fuel moisture relationships. Continuous records obtained for pertinent weather variables and fuel moisture indicator sticks. Fuel moisture samples from ponderosa pine stands of varying density and from adjacent brush areas collected on a routine schedule July through October. Data summarized but not yet analyzed.

7. Plans for next year — Continuing to increase volume of data, particularly at upper and lower limits of variables measured.

8. Date of completion — Continuing with extension to other fuels.

9. Assignment — Buck, Fons.

RS-CAL
FIRE
Behavior
Fire ignition

January 1941

Behavior - Forest Fire Ignition

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Behavior - forest fire ignition.

4. Purpose — To obtain basic information on the relative probability of ignition of specified forest fuels by several types of important firebrands. The ultimate objective is to relate the probability of ignition to fire danger rating measurements.

5. Review of past work — This study was begun in 1939 with a review of work done elsewhere and with the development of experimental techniques.

6. Accomplishments during past year — Experimental technique was developed for determining the probability of ignition of fuel in prepared beds by cigarettes. A gun was developed for lighting the cigarettes and ejecting them onto the prepared beds. 120 tests (20 cigarettes per test) using pulverized Douglas fir punk as fuel were made in a wind tunnel. Wind velocity and fuel moisture content were varied from 0 to 10 m.p.h. and 4 to 17 percent, respectively. Fuel and air temperatures during tests remained at $60^{\circ} \pm 10^{\circ}$ F. Preliminary analysis indicates maximum probability of ignition at about 5.5 m.p.h. velocity measured 12 inches above the fuel bed surface.

7. Plans for next year — Extension to other fuel types using different kinds of firebrands.

8. Date of completion — Indefinite.

9. Assignment — Fons.

RS--CAL
FIRE
Behavior
Rate of spread

January 1941

Behavior - Brush Test Fires

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Behavior -- brush test fires.

4. Purpose — To determine the influences of wind velocity and fuel moisture content upon rate of spread in the northern California brush type.

5. Review of past work — Thirty--three fires burned and results analysed. Found the additional factors of fuel arrangement and relationship of green to dead fuel in need of measurement before satisfactory correlation possible. Project held up until methods of measuring fuel factor are developed.

6. Accomplishments during past year — No fires studied in 1940.

7. Plans for next year — Small number of fires to be studied to test fuel measures adopted.

8. Date of completion — Continuing.

9. Assignment — Buck, Fons, Blanchard.

RS-CAJ
FIRE
Control
Firebreaks

January 1941

Control - Firebreaks

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Control - firebreaks.

4. Purpose — To determine the effectiveness of firebreaks under California conditions with particular reference to the southern group of forests.

5. Review of past work — A study of firebreak effectiveness made by Cecil reported in 1935. Studies of maintenance through stump eradication and soil sterilization included in "Chemical control of vegetation," in this report.

6. Accomplishments during past year — Five recent large brush fires were studied on the ground, particularly the location of final control lines in relation to cover and topography. This approach is expected to result in a better understanding of where firebreaks and firelines should be located. Indications are that certain locations offer superior possibilities for firelines and/or firebreaks but that wind surveys are necessary to fully establish their value.

7. Plans for next year — Continue study of recent fires and complete appraisal of past fires as a source of data.

8. Date of completion — Indefinite.

9. Assignment — Abell.

RS-CAL
FIRE
Control
Fire danger rating

January 1941

Control - Fire Danger Rating

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Control - fire danger rating.

4. Purpose — To develop for Region 5 methods of measuring day-to-day fluctuations in the variables influencing fire behavior and of correlating these measurements into an expression of current fire danger. The ultimate purpose of fire danger rating is to permit more effective organization for fire control activities on the national forests and other protected areas.

5. Review of past work — Fire danger rating was first undertaken in California in 1937. That year a tentative system based on local research in fire behavior and fire danger rating experience in other regions was placed in operation on four forests. The following year the system was slightly modified and extended to eight additional forests. The rating system was thoroughly revised early in 1939 in accordance with experience and analysis of records of the past two years. The system was extended to all Region 5 forests.

6. Accomplishments during past year — Assistance furnished the Region in developing methods and equipment for manufacturing moisture content indicator sticks, and in securing use of uniform sticks by all the western Regions. Procurement Division has assumed manufacture to these specifications and supplies the needs of all agencies using $\frac{1}{2}$-inch sticks. Field work during 1940 confined to checking R-5 moisture indicator stick manufacturing and selecting methods through daily observation of selected sticks at Pilgrim Creek Nursery field station. Rate of spread table for danger rating revised on basis of 1939 wind tunnel studies. Summary and analysis of daily wind and moisture observations from all national forest stations completed by Experiment Station statistical section.

7. Plans for next year — R-5 danger rating system undergoing current revision prior to 1941 season. A method for integrating the influence of herbaceous vegetation variations is to be developed.

8. Date of completion — Continuing until such time as a fully satisfactory system has been developed.

9. Assignment — Buck, Abell, Blanchard.1/

1/ Absent on extended detail at Massachusetts Institute of Technology.

RS-CAL
FIRE
Control
Fire suppression

January 1941

Control - Suppression Methods and Equipment

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Control - suppression methods and equipment.

4. Purpose — Improvement of fire suppression methods and equipment used in the California Region. Specific study is being made of organization for large fires, development of fire-fighting equipment and evaluation of resistance to control by cover types.

5. Review of past work — In 1933 a power-driven motor saw was developed for clearing fire line. It has undergone several subsequent modifications. In 1937 a study of rate of line construction was begun on the Shasta Experimental Forest through controlled experiments in 5 common types. The following year the study was extended to all California national forests in cooperation with the administrative organization. Data from 200 tests were secured. From 1936 to 1939 an experimental organization for the suppression of large fires was developed on the Shasta Experimental Forest. The principal benefits were in stimulating thought on this important problem throughout the Region.

6. Accomplishments during past year — The new model brush saw was perfected. The experimental organization for control of large fires was discontinued. Observation and study of overhead units on fires visited was continued. Laboratory study of wetting agents for improving suppression qualities of water undertaken. A simple technique for demonstrating the catalytic effect of chemicals upon combustion of wood fiber was developed.

7. Plans for next year — The brush saw is to be given extended field trials to secure performance data. Observation and study of large fire overhead organizations to be continued. The effects of promising wetting agents on laboratory scale fires will be determined. Positive results will be further tested in the field.

8. Date of completion — Development work on the brush saw to be completed by end 1941. Large fire organization study continuing. Rate of line construction indefinite. Use of water and chemicals indefinite.

9. Assignment — Brush saw - Buck, Morrow.
Fire organization - Buck, Abell.
Rate of line construction - Abell.
Use of water and chemicals - Bruce.

RS-CAL
FIRE
Control
Sterilizing soil and
killing vegetation

January 1941

Control - Chemical Control of Vegetation

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Control - chemical control of vegetation.

4. Purpose — To determine effective methods for maintaining firebreaks, right-of-ways, and other improvements in a fireproof condition, particularly through application of chemicals to kill sprouting stumps and to control herbaceous and other surface vegetation.

5. Review of past work — Study of control of vegetation by chemicals started in 1934. Practical methods for killing sprouting stumps have been developed. Plots for determination of effectiveness of plant poisons in soil sterilization against annuals established on both northern and southern forests, the latter to determine practicability of sterilizing easily erodable soil. Several stump killing and soil sterilization demonstrations established. Mimeographed instructions issued and several papers published.

6. Accomplishments during past year — All plots and demonstration areas reexamined. New plots established at Eureka, Los Banos, and Big Bear Lake. Cooperation given Shasta and Sequoia National Forests and to the Pacific Gas & Electric and San Joaquin Power & Light power companies and to the Southern Pacific railroad in sterilizing soil around sub-stations and along right-of-ways. In conjunction with the Botany Division of the University of California at Davis, a paper has been written to reveal the influence of soil type upon the effectiveness of certain soil sterilizing chemicals. Another paper on soil sterilization was published for the farm interests in the Pacific Rural Press.

7. Plans for next year — No new experiments contemplated. Established plots to be re-examined for data as to the gradual decrease in sterilization effectiveness. More demonstrations planned on northern California forests, particularly on roadsides and telephone and power right-of-ways.

8. Date of completion — Proposed completion in 1944.

9. Assignment — Bruce.

RS-CAL
FIRE
Control
Radius of vision

January 1941

Control - Radius of Vision

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Control - radius of vision.

4. Purpose — To determine and measure the factors affecting the detection time of fires and the factors influencing a dependable detection distance from a fire lookout.

5. Review of past work — This study was begun in 1933 with laboratory studies on the influence of direction of illumination on the brightness of a smoke column and with observations on 200 test fires in the ponderosa pine type. The studies indicated that the pertinent factors are: (1) distance, (2) rate of fire spread, (3) atmospheric haze, and (4) direction of the sun. Two papers covering results of these studies have been published. A theoretical physical analysis of the problems was made establishing and defining the many variables upon which radius of vision depends.

6. Accomplishments during past year — A paper entitled "Theoretical analysis of the visibility of a smoke column" was prepared and has been accepted for publication by the Journal of Agricultural Research. A smoke candle was formulated to duplicate in appearance and density the smoke from a small southern California brush fire. About 150 of these candle smokes were observed in the southern California forests under a wide range of haze and illumination, as part of a special study of southern California detection problems. Tests were begun to determine actual discovery time of fires reported by the public.

7. Plans for next year — It is planned to augment the field data obtained in 1940 with additional observations to establish the relation between the visibility distance of the small candle smoke and the angle of illumination and the atmospheric haze, with the dark southern California brush as a background, and to establish basis for determining expectancy of different degrees of haziness in southern California.

8. Date of completion — Atmospheric visibility indefinite. Southern California detection study 1943.

9. Assignment — Bruce, Abell.

RS-CAL
FIRE
Control
Statistics

January 1941

Control - Statistics

1. Field division — Forest Management Research.

2. Work project — Forest fire protection.

3. Line project — Control - statistics.

4. Purpose — The objectives of the statistics project are to currently codify all fire report data of California national forests and to conduct current studies of records to show results and trends in fire protection effort.

5. Review of past work — Analysis of fire control data for the northern California national forests published by Show and Kotok in 1923. Results of numerous subsequent analyses by same authors published as Department circulars and bulletins. All fire report data since 1911 placed on punch cards with that since 1924 recoded and punched on three 80-column cards. Data used primarily in current Regional fire replanning project; 250 summary tables prepared for each southern forest as basis for problem analysis.

6. Accomplishments during past year — Data on rates of spread and optimum size of crew contributed to Regional replanning project. Technical note issued giving expected rates of spread in each inflammability zone in each forest. In collaboration with Regional Forester and staff, completed study offering statistically substantiated basis for planning for protection in southern forests. Work continued on development of research program for southern forests.

7. Plans for next year — Complete preparation of research program for southern California. Prepare paper on determination of optimum size of crew and possibly one on line construction.

8. Date of completion — Continuing.

9. Assignment — Abell.

RS-CAL
GENETICS
General

January 1941

Field Tests of Natural Species, Strains and Hybrids

1. Field division — Forest Management Research

2. Work project — Forest Genetics

3. Line project — General - field tests of natural species, strains and hybrids of pine.

4. Purpose — a. To study the rate of growth and adaptability of the most promising species, strains and hybrids developed by or assembled at the Institute of Forest Genetics.

b. Cooperate with Regional Planting Office in devising a planting plan by which 10,000 or more individuals of each strain may be planted instead of only 50 or 60 as in the present sample plots. Alternate rows of selected and standard stock will be used.

c. To ascertain and group by elevational zones the Institute seed trees that have given the most rapidly growing offspring and to develop techniques for collecting and handling seed from such selected trees.

d. To cooperate in developing techniques for large scale pollination to produce abundant supplies of seed of the most promising hybrids.

e. To take measurements, survival counts and other records in the nursery arboretum and plantations, to analyze data and make recommendations of applicability of results and needs involving further research.

f. To test offspring of limby, forked and spiral grained trees to ascertain heritability of these undesirable characteristics.

5. Review of past work — The ground work for this project has been done in the species and progeny test program. Very little field testing of ponderosa pine has been done by the Institute. Plantings of exotic species furnished by the Institute of Forest Genetics are growing in several parks in California, but their response has not been studied closely.

6. Accomplishments during past year — Promising races, species, individuals and hybrids have been selected for further testing. Preliminary arrangements have been made with the Regional Planting Inspector for propagation and planting cooperation.

7. Plans for next year To classify the best Institute seed trees by elevation zones. To collect seed from these trees and to cooperate in its sowing at the Institute and Regional nurseries. To cooperate in pollination for large scale production of hybrid seed. To cooperate with the Regional Planting Officers in preliminary selection of national forest planting sites suitable for first outplanting operations in the fall of 1942. To classify existing Institute seed trees (approximately 100 have offspring in arboretum) into form classes representing limbiness, forking, spiral grain etc., and examine the offspring of these trees for the characters exhibited by the parent, thus determining the hereditary potentiality of forest seed trees having important, undesirable characters. To prepare a general arboretum publication describing the growth and adaptability of the trees and their value for forestry or ornamental purposes. To include in this publication notes on the behavior of exotic species of pines at other localities in California where the Institute of Forest Genetics has been of assistance in establishing such plantings.

8. Date of completion Continuous project.

9. Assignment Weidman, Righter and others.

RS-CAL
GENETICS
Breeding

January 1941

Pollination Technique, Hybridizing and Selfing

1. Field division — Forest Management Research.

2. Work project — Forest Genetics.

3. Line project — Breeding - pollination technique, hybridizing and selfing.

4. Purpose — a. To improve the pollination technique.
b. To hybridize pines for the production of forms that will be superior in usefulness to existing forms — and that will be suitable for analytical purposes.

c. Selfing to effect recombinations, to obtain homozygous forms, and for the study of inheritance in the genus Pinus.

5. Review of past work — a. Techniques have been developed for most phases of the work (collecting, extracting, germinating, and applying the pollen, and isolating the ovulate flowers). The practical effectiveness of some features is, as yet, subject to question. Theoretically, the techniques are adequate if properly used.

b. More than 5,000 species and varietal crosses, exclusive of reciprocals, are possible in the genus Pinus. More than 200 such crosses (4 percent) had been attempted prior to 1940. Of them, 70 represent crosses within relationship groups (about 1,200 are possible) and 130 between relationship groups (about 3,800 are possible). Most of the crossing attempts (about 145) were made prior to 1931 but since that date several important improvements have been made in the pollination technique. Consequently, many of the failures of early trials are not regarded as conclusive. Observations to date indicate that seven crosses were made prior to 1937. They follow: (1) P. attenuata x P. radiata; (2) P. echinata x P. caribaea; (3) P. echinata x P. taeda; (4) P. ponderosa x P. arizonica; (5) P. jeffreyi x P. ponderosa; (6) P. ponderosa x P. ponderosa var. scapulorum; (7) P. rigida x P. taeda. Crosses (2), (3), (5), (6), and (7) are very promising with respect to vigor and form. Cross (1), although involving species of relatively small economic importance, is very impressive since it is intermediate between the parental forms in vigor and frost-hardiness. The cross (P. palustris x P. caribaea) made by Walsley at the southern station and grown at the Institute is also very impressive.

c. Eight species were selfed prior to 1931. Results were not consistent, probably because of defects in the pollination technique. The hybrid P. attenuata x P. radiata was selfed and back crossed to the parental forms in 1934. The progenies are quite variable, as was expected theoretically.

6. Accomplishments during past year

a. The pollen germination technique was improved so that such tests can be set up more quickly and with greater precision. Sterilization tests conducted with more species than previously used in such tests indicate that pine pollen must be exposed for 15 hours to a temperature of 80° C. in order to render it unviable. Exposure to higher temperatures for a shorter period, which would have the same effect, would damage the pollination bags and therefore cannot be recommended. The results of the 1938 pollinations were inconclusive with respect to the pollination technique because of the ravages of squirrels and insects. The results of the 1939 pollinations indicate that the technique is highly effective.

b. Seeds from the 1938 tests were sown, and 37 interspecific crosses were attempted, of which 13 had been attempted previously. Thirteen of these new crosses were made in an attempt to obtain a white pine which will be immune to the blister rust. The method used involves transferring the immunity of species such as P. ponderosa and P. jeffreyi to P. lambertiana and P. monticola by first crossing the former with P. aristata and P. balfouriana and then crossing the hybrids with the latter.

c. Seeds from the 1938 pollinations were sown and cones from the 1939 pollinations were collected. One new self was attempted.

7. Plans for next year

a. Improve pollination technique, particularly the storage of pollen.

b. Establish a few species crosses; sow seed from the 1939 pollinations.

c. Self P. attenuata x P. radiata.

8. Date of completion

Continuous project with progress, and final reports on various phases to be made.

9. Assignment

Righter, Mirov, Stockwell, Cumming, Liddicoet.

RS-CAL
GENETICS
Cytology

January 1941

Cytology

1. Field division — Forest Management Research.

2. Work project — Forest Genetics.

3. Line project — Cytology and related studies.

4. Purpose — a. To study the structure and development of the reproductive tissues of certain species of pine as an aid to breeding new forms and analyzing the behavior of those forms under observation.

b. To attempt to discover or produce pines with an abnormal chromosome number. Plants with abnormal chromosome numbers have, in some species, proved of particular value economically and almost half of the commercially important plant varieties have abnormal chromosome numbers.

5. Review of past work — a. Fixations of material have been made, embedded and some slides made. The developmental cycle of ponderosa pine in the Placerville region was worked out roughly for the major stages.

b. 1. Abnormal pollen was produced by heating catkins but in such quantity and of such low viability that the method does not seem practicable at the present time. Seeds produced by heated cones were planted but no abnormal seedlings survived.

6. Accomplishments during past year — a. The developmental cycle in ponderosa pine has been worked out in more detail but more time is needed for completion of this study.

b. 1. Several sets of twin seedlings have been produced for study (in some species polyploidy sometimes occurs in one member of a pair of twins).

2. Several dozen pine seeds were X-rayed and planted in definite order. The seedlings will be measured and their growth related to the size of the embryo as shown by the X-ray picture. There is some difference of opinion among botanists regarding the relation of embryo size to inherent vigor of the resulting plants.

3. Cytological examination has been made of several lots of trees that have received various chemical and physical treatments. Polyploid cell groups have been found in embryos treated with colchicine. Other embryos and plants show morphological abnormality but no cytological derangement has yet been found in them.

7. Plans for next year — a. Complete the outline of the developmental cycle if time permits.

b. 1. Check the chromosome numbers of the twin seedlings on hand. Plant more seed (probably 500 seeds) for the production of twin seedlings.

2. Complete the study on the relation of seed size to inherent vigor of young seedlings.

3. Complete cytological analysis of seedlings treated by chemical or physical means. This requires further work on cytological technique applied to vegetative parts.

4. Make cytological examinations as necessary for other staff members.

8. Date of completion — Available time will determine whether a and b 2. can be completed by November 1941. b 1. and b 3. will be continued.

9. Assignment — Stockwell, Cumming.

RS-CAL
GENETICS
Breeding

January 1941

Dendrology

1. Field division — Forest Management Research.

2. Work project — Forest Genetics.

3. Line project — Breeding -- dendrology.

4. Purpose — a. To study and collect propagating or breeding material (seeds, cuttings, plants, pollen) of naturally occurring hybrids and other unusual pines of possible value in the breeding program.

b. To identify and determine the phylogenetic relationship of the trees produced and used in the experimental program.

5. Review of past work — a. Collection and use of pollen from field hybrid between Jeffrey and Coulter pines.

b. Data on pine species assembled.

6. Accomplishments during past year — a. Collected pollen, cuttings, and the few available seeds from hybrid between Jeffrey and Coulter pines.

b. 1. Continued library research on pine species, nomenclature and synonomy.

2. Devised and tested techniques for identification of juvenile forms of pine species. Such identification needed in order that hybrid plants may be recognized with certainty in seedbed — thus reducing cost of handling and care in hybridization work.

3. Checked identity of 375 arboretum trees from vegetative characters in the course of studies on identification of juvenile pines.

7. Plans for next year

a. Continue search for field hybrids and promising field trees as opportunity affords. The most satisfactory methods of locating promising or unusual seed trees have been: (1) Personal reports of competent foresters or botanists. Such reports are investigated and the localities visited when possible. (2) Examination of herbarium collections. The collector usually takes the extraordinary rather than the average specimen. When collections show such characters as unusual cone size, large, vigorous branchlets, prolific seed formation or when indications of hybridity are apparent the locality of the collection is noted and a visit is made to the tree when convenient.

b. 1. Continuation with NYA assistance of the library research on synonomy and compilation of original descriptions of pines.

2. Analysis of supposed hybrid seedlings in the seedbeds in an effort to select the valid hybrids with certainty.

3. Continuation of arboretum identification studies.

8. Date of completion — Continuous.

9. Assignment — Stockwell, Righter, Cumming.

RS-CAL
GENETICS
Physiology

January 1941

Improvement of Pines by Physiological Means

1. Field division — Forest Management Research.

2. Work project — Forest Genetics.

3. Line project — Physiology - pine improvement.

4. Purpose — To study the normal growth and behavior of pines and their response to abnormal conditions and stimuli, priority being given to problems of current importance in connection with the breeding program.

5. Review of past work — Analysis of technique, review of the literature on the subject, and experimental plans drawn up for studies of nutrition, grafting and hormone analysis of the pines. Preliminary tests were conducted in each case.

6. Accomplishments during past year — One series of experiments have been completed during the past year. These include the studies of grafting technique, methods of detecting growth hormone, and nutritional-deficiency studies. Manuscripts have been submitted to the Journal of Forestry presenting the first two subjects. (It is of special interest that the work on growth hormone indicated a relationship between rapidity of growth and hormone content.)

Work on the rooting of pine cuttings has been continued and a progress report is planned for publication this year.

Several dozen seedlings, produced from seeds treated by various chemicals, are in culture. Some of these show morphological differences to normal pine seedlings, but the extent and significance of these differences have not yet been analyzed.

7. Plans for next year The studies of rooting cuttings and seed treatment will be continued and some new physiological work is planned. The hormone studies will be expanded to include mature trees with the hope that a correlation between hormone content and vigor may be found that will aid in the selection of vigorous forest seed trees.

Because of variation in time of pollen shed between species it is often necessary to store pollen from one season to the next for hybridizing purposes. Tests are planned to determine the optimum conditions for pollen storage.

The interrelationship between stock and scion will be studied in conjunction with the grafting of species and forms of pines.

Despite the many studies conducted on forest tree planting, this difficult and necessary activity is not always successful. Although little or no control can be exercised over climatic and edaphic factors that cause losses of planted stock, many improvements have been developed by the Forest Service in the selection of seed, culling of nursery stock, and techniques of digging, handling and planting the trees. Survival of planted stock may depend, to a considerable degree, on an adequate, well-shaped, uninjured root system. For this reason studies of the adaptability of pines to water culture will be continued and expanded. Planting of stock with well-formed, uninjured roots will give more reliability to experimental work and may possibly lead to better technique for production of planting stock in general.

8. Date of completion Continuous.

9. Assignment Mirov.

RS-CAL
GENETICS
Racial Variation
Progeny Tests

January 1941

Progeny Tests and Provenience Studies

1. Field division — Forest Management Research.

2. Work project — Forest Genetics.

3. Line project — Selection - progeny tests and provenience studies.

4. Purpose — a. To investigate the fundamental principles underlying the improvement of timber trees through progeny testing, and thus gradually to develop improved technics that will have wide application.

b. To compare the growth rates, climatic adaptability, and relative timber-producing characteristics of regional and elevational strains of ponderosa pine.

c. Within each desirable strain, to discover individual seed-trees that, with natural wind pollination, regularly yield superior progenies, for these trees will be valuable as seed sources for either natural or artificial reforestation.

5. Review of past work — An early nursery and plantation test of provenience utilizing seed from 765 individual seed-trees of ponderosa pine growing in 12 of the western states and British Columbia has shown that this major species is composed of various geographic and elevational strains that are genetically distinct. Although there is much local variation and it is difficult at this stage to make broad generalizations, it may be said that relatively slow growth has been made at the Institute by races originating at high elevations or in extreme northern latitudes. Within local strains the individual trees vary greatly in their ability to produce desirable progeny. This was indicated in the early test started in 1929, and has been shown much more fully in the progeny test that was sowed in 1937. Seed sources for this experiment were limited to the local El Dorado region for the purpose of ascertaining the amount of hereditary variation that occurs within a limited area. Quasi-factorial designs were used for both the nursery and plantation phases of the test, which will soon be old enough to yield results of great interest.

6. Accomplishments during past year — The Institute's first series of transect plantations was set out early last spring at low, medium and high elevations in El Dorado County to test the persistence of the striking results secured at the end of the 2-year nursery phase of these tests involving elevational strains of El Dorado ponderosa pine. Various previous experiments conducted at the Institute have shown a growth superiority of the local elevational strain collected between 2,000 and 3,000 feet. In the absence of similar tests with nurseries at other elevations, it has seemed possible that this might be a case of the local strain doing best because of natural adaptation, and that other strains might excel if grown in their own native environments. The transect nursery tests just completed seem to have definitely disproved this supposition, since this same 2,000 to 3,000-foot strain made the best growth at all three elevational nurseries. The strain from high elevations (5,000 to 6,000 feet) grew more slowly at all nurseries, including the one at the elevation where that seed was collected. These findings indicate that it may prove possible to apply over wide areas the results secured in past and future tests that are conducted only at the Institute. One serious question, namely that of survival, remains. The degree of cold that low elevational strains will survive is not known, but to date no injury from cold has been sustained by them.

7. Plans for next year — The work on this project during the coming year will be principally as follows: (1) thinning the 1929 progeny test plantation, (2) watering and other care of the 1937 plantation and the three transect plantations, (3) analysis of back data, (4) completion of tree-location work in this region.

8. Date of completion — Continuous with reports or publications at periodic intervals.

9. Assignment — Austin, Liddicoet.

RS-CAL
GENETICS
Racial Variation

January 1941

Species Tests

1. Field division — Forest Management Research.

2. Work project — Forest Genetics.

3. Line project — Racial variation - Species tests.

4. Purpose — a. To determine the relative growth capacities, timber-producing characteristics and climatic adaptability at the Institute and vicinity of the pine species of the world and their geographical races.

b. By means of a number of paired tests for each species, to compare the subsequent arboretum development of seedlings that are vigorous and normal in the nursery.

c. To assemble as complete a collection as possible of the known pine species and their geographical races to facilitate hybridization experiments.

5. Review of past work — The Institute's arboretum, believed to be the world's largest collection of pine species, contains over 100 species and varieties, with numerous geographical strains of many of the species having wide natural distribution. The arboretum also includes 35 species of conifers belonging to other genera, as well as 20 species of hardwood timber trees. The oldest trees are now 15 years old and some of them, particularly those of Monterey pine (Pinus radiata) and cluster pine (P. pinaster), are now nearly 50 feet tall. Conditions at the Institute are such that a great majority of the species thrive and make good growth even though assembled from many widely separated parts of the world having diverse soil and climatic conditions. Over 50 species of pines have already reached the flowering age, and thus are available for breeding purposes.

To test cold hardiness and snow resistance and to provide later blooming material, a small plantation is located at Freshpond, about 1,000 feet higher in the Sierra than the Institute. This plantation contains 40 species of pines and the response there has been quite different from that secured with corresponding species at the Institute. Certain species, among them the cluster pine, have suffered much limb breakage from the relatively heavy snowfall at Freshpond and some species such as Monterey pine cannot survive the cold.

6. Accomplishments during past year — Periodic remeasurements of height, diameter, and branches were taken of all arboretum trees that had reached the ages of 10 and 15 years. Seed was secured from Mexico and sowed during 1940 of 12 species and varieties of pines not as yet represented in the arboretum, namely: Pinus montezumae rudis, P. montezumae uruapanensis, P. oocarpa manzanoi, P. oocarpa ochoterenae, P. pringlei, P. lumholtzi, P. ayacahuite brachyptera, P. strobus chiapense, P. nelsoni, P. pinceana, P. duranguensis, and P. herrerai.

7. Plans for next year — Periodic remeasurements and compilations will be kept up to date. The seven pine species grown in the 1939 nursery will be set out in their permanent places during the winter. Efforts will be renewed to secure seed of pine species that are still missing in our arboretum and nursery. These are chiefly the following: Pinus brevispica, P. cambodgiana, P. funebris, P. taiwanensis, P. uyematsui, P. lawsoni, P. leiophylla chihuahuana, P. montezumae lindleyi, P. ponderosa macrophylla, P. pseudostrobus apulcensis, P. pseudostrobus tenuifolia, P. cubensis and P. ponderosa mayriana. The first five forms are native to Asia, the last two to the United States, and the rest to Mexico, a country which is unusually rich in species and varietal forms of pines.

8. Date of completion — Continuous project. Progress reports or publications at periodic intervals.

9. Assignment — Austin, Weidman, Stockwell, other staff members as needed.

RR-CAL
ARTIFICIAL REVEGETATION
Species

January 1941

Species-Survival Testing of Range Forage Plants - Foothill Ranges

1. Field division — Range Research.

2. Work project — Artificial revegetation.

3. Line project — Species-survival testing of range forage plants.

4. Purpose — To test valuable forage species from various regions and countries for adaptability to California foothill conditions — a step necessary for selecting most promising plants for large-scale testing and improvement of the range.

5. Review of past work — Row-survival tests started in the fall of 1934 at the San Joaquin Experimental Range. Total number of species tested or being tested: 189. Tests include seed furnished primarily by Bureau of Plant Industry and secondarily by various other agencies — federal, local, and foreign. Special attention given to annual plants since existing plant cover indicates these to be best adapted to the area. Perennials, especially shrubs, also receiving considerable effort. Subterranean clovers, wimmera rye grass, and shadscales have shown good promise in nursery. Several species planted in range competition plots, where garden burnet has shown good promise, having lived since 1937 and produced seed each year. However, none have shown enough promise to warrant recommending extensive planting on the range.

6. Accomplishments during past year — Thirty-six new species or strains added to list of those being tested in forage nursery, bring total to 225. These include 25 different alfalfas furnished by the Bureau of Plant Industry, from India, Turkey, Chili, Manchuria, Afghanistan, China, Ecuador, Russia, Turkistan, and this country. Some of these survived and produced a good forage crop and many seed the first year. Creeping-rooted alfalfa has shown unusual promise. Subterranean clover did especially well in the nursery this year. Phosphate-fertilizer treatments on this species showed little effect but studies of this type should be carried further. Some 25 species planted in competition plots, and these have shown more promise than ever before.

7. Plans for next year — Continue observations of row tests, adding new species and replanting some. Discontinue weeding of rows planted out on range. Plan and establish additional competition plots for uniform survival tests of promising species and strains, broadcast and under competition with annual foothill forage.

Make limited observations on other phases of revegetation program, including methods of seedbed preparation and of planting,

phosphate fertilization, grazing and clipping, and palatability of selected species.

Overhaul working plan and prepare detailed study plans for new phases of work.

8. Date of completion — Continuing project as necessary part of the revegetation program.

9. Assignment — Talbot, Biswell, Bentley.

RR-CAL
MANAGEMENT
Utilization Standards

January 1941

Utilization Standards, Grazing Capacity, and Season of Use - Foothill Ranges

1. Field division — Range Research.

2. Work project — Grazing management.

3. Line project — Utilization standards, grazing capacity, and season of use.

4. Purpose — To improve yardsticks or standards which will enable one to judge degree of use of a range and its condition more positively. To determine relationship between closeness and period of grazing the range, and the kind, amount, and duration of forage which it produces. This necessary for recognition and definition of allowable use which will maintain satisfactory range condition.

5. Review of past work — Six pastures (2 small, 2 medium-sized, and 2 large) established in 1935 at the San Joaquin Experimental Range; since 1937 have each been stocked from January to August with about 15 head of cows. Counting bulls and calves, the different rates of stocking are approximately 9, 14, and 18 acres per animal unit for 7 months. Cattle spend remainder of year on holding pastures where one group is supplemented.

Utilization of each pasture determined each year from general examinations and from measurements made on 60 permanent plots. Tentative yardsticks for measuring utilization include percentage of plants grazed, height of remaining stubble, and percentage of ground objects obscured by remaining vegetation. What has happened under the different degrees of use was recorded by photographs, by an annual inventory of forage on approximately 600 temporary plots, and by other forage measurements. More early feed is usually produced following moderate utilization. Measurements in 1938 and 1939 showed new forage on moderately used areas to be 2 to 3 weeks in advance of that on closely used areas. Under complete protection from grazing, forage composition deteriorates, tending to change from such plants as filaree and low-growing grasses to the less desirable tall-growing grasses such as ripgut grass and slender oat. The change-over found to be most rapid and most complete on best sites, where in one case the measured change in 2 years was from 2 percent grass to 96 percent grass.

6. Accomplishments during past year — Study continued as before. About 12 acres per cow, with calf to weaning time, resulted in close grazing for time cattle on test pastures. Results to date indicate that about the same acreage per cow is required for the remaining 5 months of the year, from August to January, as from January to August. Also indicate that 20 to 25 acres per cow per year, with calf to weaning time, results in fairly close use. For moderate utilization 8 or 10 acres more required per head.

Degrees of utilization of the pastures have not been consistent with differences in pasture size. For example, one medium-sized pasture has been grazed lighter than the larger pastures. Pounds gained per animal unit while on test pastures have been less in very closely grazed areas than in others grazed less closely. Forage inventories of entire pastures have not shown any definite relationships between rates of grazing pastures for a 7-month season and trends in density or composition of forage. However, utilization resulting in equal closeness during a shorter grazing season may yield entirely different results. Moreover, the longer cumulative effects of close grazing are not yet known; for example, no drought years have as yet been studied in this experiment. Other comparisons were made this last year within 6 large temporary exclosures placed astraddle of fence-line between a closely grazed and a lightly grazed pasture. Differences in forage yield on opposite sides of fence were not significant, but differences in average height of vegetation proved significant, average being 3.2 inches for the closely grazed pasture and 4.3 inches for the one grazed lightly. Studies of seed production in these two pastures revealed large number of seed cast under both light and heavy grazing, accounting in part for only small changes in composition.

Results to date from project analyzed and included in an interagency progress report covering entire program at the San Joaquin Experimental Range. Manuscript, to be published as a University bulletin, now in hands of University board of review and should be in press within a few weeks.

7. Plans for next year — The project will be continued but methods subject to modifications indicated as desirable by analysis of working plan.

8. Date of completion — A continuing project.

9. Assignment — Talbot, Biswell, Bentley, Nelson

RR-CAL
MANAGEMENT
Foothill Ranges

January 1941

Effect of Grazing on Surface Run-off, Erosion and Infiltration Capacity - Foothill Ranges
(In cooperation with Division of Forest Influences)

1. Field division — Range Research.

2. Work project — Grazing management.

3. Line project — Effect of grazing on surface run-off, erosion, and infiltration capacity.

4. Purpose — To determine effect of different intensities of grazing on (1) surface water run-off, (2) soil erosion, and (3) infiltration. Highly important to know whether, and to what degree, soil erosion is reducing productive capacity of granite soils. In addition, there is increasing demand for data on water production and floods. Run-off and infiltration data obtained from these plots will also have bearing on these problems.

5. Review of past work — Installation consisting of 3 triplicate sets of 1/40-acre plots established in 1934 on San Joaquin Experimental Range. Until March 1938 cover on plots was undisturbed. During this calibration period there was no erosion, and surface run-off was less than 1 percent of precipitation, indicating an infiltration capacity of soil under ungrazed forage cover equal to or in excess of the highest rainfall intensities occurring during that period. Surface run-off from these plots should not be confused with total water yield, which would include percolation.

Since March 18, 1938, 3 plots grazed heavily (by sheep), 3 moderately, and 3 ungrazed as checks. No increase in run-off during remainder of that season or during 1939. Closely grazed plot almost bare of litter; protected plot has litter at least 1/2 inch deep. Erodium botrys, Bromus mollis, and Festuca megalura make up most of the vegetation on these plots.

6. Accomplishments during past year — Grazing of the plots continued through a third season. Forage density at time grazing began was 59 percent on plots used closely the previous season, 57 percent on those moderately used, and 67 percent on the protected plots. One of biggest changes in composition was an increase in Calandrinia on the grazed plots; it increased most on those most closely used. Utilization on closely used plots averaged 97 percent; on those moderately used, 62 percent. In spite of grazing no appreciable increase in run-off took place last year under a precipitation of 21.2 inches.

Infiltration tests showed that moderate grazing has brought about significant reductions in the infiltration capacity of the soil on the plots, and that under heavy grazing reductions are highly significant. For example, the mean infiltration capacity, with soil at field-moisture capacity, is: ungrazed plots, 8.0 inches per hour; moderately grazed, 5.8; and closely grazed, 3.4. There is a direct relationship between intensity of grazing and reduction of infiltration capacity of the soil; however, the mean capacity even under close grazing is still above the rainfall intensities which have occurred on these plots, except for a few peaks of very short duration.

7. Plans for next year — Continue grazing as for last year.

8. Date of completion — Probably graze the plots at above rates for at least 3 more years, to build up any effects from continued heavy grazing, to obtain a better representation of total amount and seasonal distribution of precipitation, and to measure the effects from the very high intensities of rainfall which occasionally occur – intensities higher than any that have occurred to date on these plots.

9. Assignment — Talbot, Biswell, Bentley (Range Division). Kraebel, Rowe (Influences Division).

RR-CAL
RANGE PLANTS
Values

January 1941

Forage Crop Values - Foothill Ranges

1. Field division — Range Research.

2. Work project — Range plants.

3. Line project — Forage crop values.

4. Purpose — To determine the composition and growth of the annual forage type, to find its seasonal values, and to follow changes in distribution, abundance, vigor, and yield of plants from year to year as affected by weather conditions, soil, etc. When more is known of effects of climatic factors on the feed, the stockman can better deal with fluctuations in range feed that characterize the annual type.

5. Review of past work — Annual inventories of forage composition and yield made at San Joaquin Experimental Range since 1935. Continuous records on climate and regular periodic records on growth also maintained.

About 99 percent of the herbaceous forage cover of the Experimental Range is composed of annuals; most of these are introduced species, averaging about 60 percent for the last 5 years. Some 225 herbaceous species have been found, but 3 account for more than half the forage. Ratio of broadleaved plants to grasses: 3:1 in 1935 and 1:1 for each of the following 4 years. Broadleaf alfileria and soft chess are the two most important forage species. Pine bluegrass, the most common perennial grass, makes up less than 0.2 percent of the forage and has shown no increase during the period of study, even in totally protected places. Perennial rushes are sparse, yet compose a considerable part of the cattle's diet when most of the other forage is nearly dry. Several browse species occur on the area but none makes up a very large percentage of the animals' diet.

The forage crop passes through three distinct periods each year: (1) Germination and start of growth after first effective fall rains (expected in October) and slow growth during 3 or 4 winter months, due mostly to low temperatures but occasionally to insufficient moisture. The range cannot be depended on to furnish sufficient forage for stock during all this period. (2) Rapid growth starting in latter February or early March and extending through April. The range furnishes an abundance of nutritious forage during this period. (3) Rapid drying of the mature forage during May and June, after which it furnishes a deficient ration during the summer until growth of the new crop in the fall.

Extreme fluctuations recorded between different years in amount of forage, composition, and time of growth and drying. A seasonal variation in either precipitation or temperature may cause a marked fluctuation in the feed. Effects of weather on feed appear to be most pronounced early and again late in growing season. The wide and irregular changes in forage produced from year to year in this annual type necessitate skillful operation on the part of the stockman, in providing supplemental feeds or additional acreage during adverse seasons, and in other ways keeping his business as flexible as possible.

6. Accomplishments during past year — Cattle-exclosure data showed air-dry yield of forage this year to be 1,073 lbs. per acre. This compares with 1,662 lbs. in 1935, 1,012 lbs. in 1936, 807 lbs. in 1937, 1,130 lbs. in 1938, and 1,020 lbs. in 1939. Early growth good this year but a drought following soon slowed it and even killed many plants. Erodium botrys and Plagiobothrys nothofulvus proved to be more drought-resistant than Bromus mollis and Festuca megalura, probably because their roots extended much deeper -- 3 feet or better, while those of the latter two species extended down only 7 to 9 inches. As a result of the shallow-rooted species dying off, the percentage of the deep-rooted species in the forage composition was exceptionally high this year. This adds one more factor to the list that produces changes in composition from year to year.

Results to date from project analyzed and included in an interagency progress report covering entire program at the San Joaquin Experimental Range. Manuscript, to be published as a University bulletin, now in hands of University board of review and should be in press within a few weeks.

7. Plans for next year — Continue study, but methods subject to modifications indicated as desirable after analysis of working plan.

8. Date of completion — A continuing study; highly necessary adjunct to the grazing-capacity experiment.

9. Assignment — Talbot, Biswell, Bentley.

RR-CAL
SUPERVISION
Biological factors January 1941

Life Habits and Management of Valley Quail - Foothill Ranges
(A cooperative interagency study)

1. Field division — Range Research.

2. Work project — Range-wildlife relationships.

3. Line project — Life habits and management of valley quail.

4. Purpose — To study general habits and environmental relationships and factors: food, water, cover, predation, disease, and population trends — with special emphasis on nesting cycle. Information necessary for formulating sound wildlife-management plans — especially information bearing on possibilities and limitations of quail management on foothill cattle ranges.

5. Review of past work — A cooperative undertaking started in 1937 between the California Forest and Range Experiment Station and Region 5 of the Forest Service; Fish and Wildlife Service (Biological Survey); California Division of Fish and Game; and Division of Zoology of College of Agriculture, University of California.

Census methods developed show a steady decline from 1 quail to 1.17 acres in 1937 to 1 to 4 acres in early 1940. The behavior of coveys, nesting, nesting periods and their relation to climate changes have been studied and reported. Predation as a factor in reducing adult quail is not serious. Losses of nests and fledglings constitute a serious gap in quail cycle. Nesting studies continued to show that ground squirrels were a serious factor in nest destruction.

All quail examined were infested with Haemoproteus, but no data available regarding its effect. Hunting experiment continued in 1939, the November census showing quail were about as numerous on hunting area as on control.

6. Accomplishments during past year — Annual census in March shows only 1 quail to 4 acres over original area — the lowest since start of study.

Nesting studies exhibited same general trends as in past years, with two exceptions: (1) Season prolonged into late summer, evidently by comparatively mild weather; (2) gopher and king snakes charged with greater nest destruction, and ground squirrels with less, than heretofore. Snake damage may have been overlooked in past. Many nests were on poisoned area, and squirrels generally are far less numerous than in 1937-1938.

Old-young ratios in August and September, as revealed by observation and trapping, showed the highest yet reached in the past nesting season. However, late fall censuses demonstrate that no appreciable gains were left by hunting season. Hunting experiment continued: showed same general trends as past two seasons. Population on hunting area was low prior to opening of season, but not alarmingly so. Seventeen artificial watering tanks tried during dry season. Tanks in place two or more seasons had greatest use by quail, and greatest effect upon quail distribution. Mechanical difficulties in operation of the tanks encountered. Studies on distribution, food habits, predation, weights, and collection of blood samples continued.

The Fish and Wildlife Service (Biological Survey) opened their disease research studies August 1, 1940, and quail of the Range are included. Ten birds of preliminary lot studied were heavily infested with coccidia. Haemoproteus also present.

7. Plans for next year (1) Summarize all past work, analyze data to determine loopholes (Glading and committee). (2) Compare the several seasons' nesting data on basis of vegetative cover, squirrel population, etc. Determine course to take on further squirrel poison areas. Continue studies as review indicates. (3) Make an intensive study of fledgling losses, and correlate with disease studies. (4) Experiment with trap types and baits to overcome seasonal differences in bait acceptance, if possible. (5) Continue disease studies intensively. (6) Endeavor to develop a census method for rapid sampling of large areas. (7) Continue water studies, especially mechanical improvement of the water devices. (8) Continue trapping and banding studies.

8. Date of completion Indefinite.

9. Assignment Field technician (to be selected) financed by Region 5. Disease research: Dr. E. L. Vail, Dr. C. M. Herman, E. E. Horn, Henry S. Fitch (Fish and Wildlife Service). Development of traps and water devices: field technician, Dr. Fitch, E. E. Horn, WPA trap shop. General committee: 10 members representing Division of Zoology, College of Agriculture, University of California; California Forest and Range Experiment Station; Region 5, U. S. Forest Service; Fish and Wildlife Service; California Division of Fish and Game. Committee of five: one from each agency.

RR-CAL
ARTIFICIAL REVEGETATION
Species

January 1941

Artificial Revegetation - Pine Ranges

1. Field division — Range Research.

2. Work project — Artificial revegetation.

3. Line project — Species.

4. Purpose — To find forage species that are suitable for planting on depleted mountain meadow and sagebrush areas on eastside ranges, and to determine the best way of getting them established.

5. Review of past work — Many of the eastside national forests have made reseeding trials in past years under fenced conditions. Prior to any particular study of reseeding problems, it is planned to examine these plots for the value they may have in planning experiments and in guiding future reseeding trials.

6. Accomplishments during past year — Two reseeded areas on the Lassen National Forest were examined.

Dry Lake Area. Twenty acres located on denuded sagebrush site: fenced 1933, planted to crested wheatgrass and smooth brome 1934, broadcast and harrowed. Germination in 1935 approximately 5 percent.

Composition in 1940

Total density 0.037

Stipa occidentalis	92 percent
Sitanion hystrix	3
Bromus inermis	3
Agropyron cristatum	2
	100 percent

Native grasses increasing inside fence; planted species not showing signs of rapid spreading. Further harrowing tried on two plots to encourage planting and establishment of seed cast from plants already growing on the ground.

Norval Flat Area. Eighty acres located on denuded meadow and sagebrush site: fenced 1933, planted to crested wheatgrass and smooth brome 1934, broadcast and harrowed. Germination and establishment took place only on meadow portion of area and even here only on better drained sites. Natives increased under fenced

protection. Also many native species became established and spread in the harrow furrows. In places solid lines of Poa and Stipa were established. Poa carried down into swale bottoms where no other grasses were growing.

Four plots harrowed to encourage further spreading of all species. Changes in specific species to be followed on 6 pairs of quadrats. Changes may be evident upon remeasurement of quadrats.

7. Plans for next year — Remeasure plots and quadrats in Dry Lake and Norvel Flat areas. Make closer observation on adaptability of species to site. Examine additional reseeded areas in eastside region.

8. Date of completion — Examination of areas reseeded by eastside forests to be completed 1942. Date of completion of new study phases undetermined.

9. Assignment — Talbot, Hormay.

RR-CAL
MANAGEMENT
Handling livestock

January 1941

Handling Livestock - Pine Ranges

1. Field division — Range Research.

2. Work project — Grazing management.

3. Line project — Handling livestock.

4. Purpose — To determine the best livestock-control methods for improving utilization of eastside ranges.

5. Review of past work — Studies limited to certain phases of the salting and watering problems, conducted at Burgess Spring Experimental Range.

Methods. Time relationships between salting and watering of cattle in a 537-acre pasture measured in 1937 to determine if cattle went to water immediately after salting. Salt placed 3/4 of a mile from water. Apparatus developed to record automatically the time cattle salted and watered.

Results. Average time interval between salting and watering: about 7 1/2 hours — significantly greater than the 30 minutes required for the animals to stroll to water from salt. These results showed the cattle did not have to water soon after licking salt; observations showed no undue trailing. Apparently there was no deterrent to placing salt a considerable distance from water. Considering the excellent gains in weight made by the cattle, detrimental effects on them could hardly be expected.

In addition, the amounts of salt and water consumed were measured during 1936, 1937, and 1938. Average consumption of salt per month by large steers: 2.34 lbs. in 1936, 2.13 lbs. in 1938; for a mixed herd containing yearlings in 1937, 1.53 lbs. Water consumption about the same each of first 2 years, averaging 7.5 gallons per head in 1936 and 7.68 gallons in 1937; not measured in 1938.

6. Accomplishments during past year — No work carried on in the field. Data on above problem phase prepared for publication.

7. Plans for next year — No work planned.

8. Date of completion — Present studies terminated. New phases under this line project expected to be undertaken in the future.

9. Assignment — Talbot, Hormay.

RR-CAL
MANAGEMENT
Ponderosa pine ranges

January 1941

Grazing vs. Pine Regeneration - Pine Ranges

1. Field division — Range Research.

2. Work project — Grazing management.

3. Line project — Grazing vs. pine regeneration.

4. Purpose — To determine the effect of livestock grazing on the regeneration of cut-over lands.

5. Review of past work — A number of measurements itemized in 1940 annual report made in various localities in the eastside region since 1932, show that practically all damage to established pine reproduction confined to bedgrounds, watering places, stock trails; does not loom as a serious regional situation. Problem of first-year seedlings, particularly with sheep grazing, more obscure; evaluation will entail long-range study under different conditions involved. Specific problem on which information is needed pointed up and methodology for study advanced.

Ground conditions are most favorable to establishment of tree reproduction immediately after logging and become less favorable with passing years as herbs and shrubs tend to occupy the ground and mineral soil is again compacted and covered by litter. Pine reproduction, however, not becoming established during this favorable period (1 to 8 years approximately) following logging on many areas in eastside region. The question is: Are livestock, especially sheep, an important factor in the failure of pine to become established during this time?

6. Accomplishments during past year — No work carried on in the field on problem stated above; however, the Modoc National Forest was interested in finding out whether establishment of pine reproduction could be encouraged by preparing a seedbed somewhat comparable to that created by logging disturbance. The Forest carried out the field treatment by tearing up ground with tractor and ripper in a number of areas in a mature pine stand near Badger Well where reproduction was unsatisfactory.

Records made of all pine seedlings 12 inches or less in height on 24 transects 8 chains long and 3.3 feet wide on these areas. Only 6 seedlings found: 2 on ripped areas and 4 on non-ripped which served as checks. Effect of this soil treatment on seedling establishment will be reflected in future measurements starting in 1941.

7. Plans for next year — Preparation of study plan and start of field work if feasible on study of effect of sheep grazing on pine regeneration on cut-over lands, with emphasis on seedling phase. Measurement of ripped plots on Modoc National Forest.

8. Date of completion — Indefinite.

9. Assignment — Talbot, Hormay.

RR-CAL
MANAGEMENT
Ponderosa pine ranges

January 1941

Logging vs. Grazing Capacity - Pine Ranges

1. Field division — Range Research.

2. Work project — Grazing management.

3. Line project — Logging vs. grazing capacity.

4. Purpose — To determine changes in forage because of logging.

5. Review of past work — Past work, at Burgess Spring Experimental Range, aimed primarily at determining best methods of studying this problem.

Methods. 1935 - Laid out and measured number and basal area of ground vegetation by species on 50 quadrats, in advance of logging, on each of six 2 1/2 x 5-chain plots located on a Forest Service timber sale area. 1936 - Logged by Fruit Growers Supply Company with tractors; slash left scattered on ground unburned. 1937 - Reexamined plots for reduction in ground vegetation.

Results. Amount of forage (weight) and changes in forage due to climate, as distinct from those due to logging, have to be measured for a satisfactory solution of this problem. These measurements not made in work to date.

The 6 logged plots showed a 19 percent reduction in palatable forage. This represents the forage actually skidded out or covered up, and does not account for the possible increase in growth of the remaining forage — even the first year following cutting — from decreased competition with the trees removed and from a general change in environmental conditions.

Indications on an adjoining area logged 2 years earlier are that reductions in forage are rapidly regained and the forage stand builds up to a greater level than existed before logging, due to increased vigor of growth. Initial reductions may not be of great practical importance even under heavy cutting — in this case about 35 percent. Slash left in place on the ground rendered only 3 percent of the area totally inaccessible to cattle.

It is felt that the findings on these six plots are indicative of what happens under heavy cutting, but more intensive sampling needed for more representative figures.

6. Accomplishments during past year	No work carried on in field. Brief report of problem and results prepared for publication.
7. Plans for next year	No work planned.
8. Date of completion	Present studies terminated. New phases under this line project expected to be undertaken in the future.
9. Assignment	Talbot, Hormay.

RR-CAL
MANAGEMENT
Utilization standards January 1941

Utilization Standards - Pine Ranges

1. Field division — Range Research.

2. Work project — Grazing management.

3. Line project — Utilization standards.

4. Purpose — To determine the maximum degree of utilization under which forage species and forage types can be maintained; and to devise simple usable standards for recognizing and determining degree of use of the range.

5. Review of past work — Past work at the Burgess Spring Experimental Range aimed primarily at determining best methods of studying this problem.

Methods. No direct studies started yet to determine what constitutes proper utilization of forage species and types.

Several methods given a trial in measuring forage utilization by cattle.

(1) In 1936, measured on 827 quadrats at four periods during season.
(2) In 1937, described at end of grazing season and tentative criteria for judging utilization established.
(3) In 1938, sampled intensively by transects at end of season.
(4) In all years, direct observations made to determine time of season utilization should be judged.

Results. Tentative criteria for judging degree of range use established in 1937. Most significant are: (1) masking by vegetation of low ground objects — pebbles and cobblestones, low rocks, pine cones, slash, cattle droppings, and fresh gopher mounds; (2) abundance of seed stalks of certain plants; and (3) ratio of grazed to ungrazed plants of certain key species. Initial photographs taken.

Cattle preferences for most species fluctuated during season; often changed abruptly. This indicates it may be possible to determine degree of use to be expected at end of grazing season by inspecting indicator species at given growth stages, but that period of grazing them must be known and considered. Rapidity with which lupine removed by increased number of stock in 1938 points out that degree of stocking must also be considered.

6. Accomplishments during past year — Established plots on the Modoc National Forest to obtain data on effect of heavy soil disturbance, comparable to that created by logging, on establishment of bitterbrush reproduction on a virgin pine timber range grazed by sheep and deer. These data fit into a life history study of bitterbrush being planned.

Treatment removed about 50 percent of established bitterbrush plants on the plots. Others were bruised and injured and may die. Seed on the ground from this year's crop no doubt was worked into the soil to various depths. Seedbed prepared by ripping looks suitable for seedling establishment for a number of years if seed produced. A reaction in growth should be observed in plants that were not ripped out.

7. Plans for next year — Re-measure Modoc bitterbrush plots. Locate bitterbrush areas, if available, that are not grazed by either livestock or deer, or are grazed only by deer, on which to measure the age class distribution of bitterbrush plants as an index of development under prevailing climate. These areas will serve the purpose of protected plots with which numerous comparisons can be made, especially of grazing treatment.

8. Date of completion — Indefinite.

9. Assignment — Talbot, Hormay.

RR-CAL
RANGE PLANTS
Values

January 1941

Forage Crop Values - Pine Ranges

1. Field division — Range Research.

2. Work project — Range plants.

3. Line project — Forage crop values.

4. Purpose — To determine the seasonal grazing value of cut-over pine and other range types, and to obtain other supporting information on the value and use of these types for grazing by livestock.

5. Review of past work — Past work at the Burgess Spring Experimental Range aimed primarily at determining the best methods of studying these problems.

Methods. Cattle were weighed at 2-week intervals to determine the best season of use and grazing value of cut-over pine land. Phenological records made to tie stage of growth of key forage species to trend in gains of cattle. Direct observations of livestock grazing made to determine composition of forage eaten by the cattle — week by week.

Results. Weights taken during the grazing period for 3 years show: (1) The cattle made greatest gains early in the grazing season before the key forage species flowered (average daily gains of more than 4 lbs. per day per cow made in June); (2) gains declined steadily from June to September; and (3) cattle lost weight after forage matured and dried. Loss not due to lack of forage but rather to nutritional deficiencies in it after middle of September. These data show forage has greatest nutritional value early in season. Early use of forage indicated, providing it can be maintained under this season of use.

Average weight gains per day for the grazing season by cattle of 1.9 lbs. in 1936, 2.0 lbs. in 1937, and 1.4 lbs. in 1938 indicate high forage value cut-over pine land may have. Festuca idahoensis, Lupinus calcaratus, Sitanion hystrix, Purshia tridentata, and Bromus marginatus made up an estimated 88 percent of forage consumed in 1937.

In 1939 weights of cattle obtained only during last 6 weeks of season. Verified previous results that nutritional value of forage declines at end of season. Cattle weight losses started 1 or 2 weeks earlier than in previous seasons due to the extreme drought year.

Records of growth and development were made periodically on 222 individual plants in 6 sites near work center — 3 in timber, 1 in sage, and 2 in meadow. General phenological observations made over all of eastside at opening of grazing season. During this drought year there was less than average difference in date of range readiness between meadows and timber. Plant growth was retarded proportionally more on meadows than on timber; consequently, meadows suffered most as result of poor year. Practically no seed produced by forage species.

6. Accomplishments during past year — Tentative plans prepared for expansion of study of forage types to include meadows. Main objective: determining best season of use and grazing values of cut-over pine timber and meadow type when used in conjunction with one another. This relationship between meadow and timber ranges has great practical significance on eastside national forests since many range allotments have large acreages of these types.

Proposed study can be carried out on Lassen National Forest, using present Burgess Spring pasture and a meadow in Squaw Valley adjoining Burgess Spring on the east. This study has been discussed with the Lassen National Forest and Regional Office and gone over on the ground. When study plans have taken concrete form they will be submitted to Washington, probably before spring.

7. Plans for next year — Complete study plans for Burgess Spring-Squaw Valley season-of-use study. Complete necessary construction and arrange for obtaining experimental livestock.

8. Date of completion — Indefinite.

9. Assignment — Talbot, Hormay.

RP-CAL
TIMBER CONVERSION
Grades and specifications
Logs

January 1941

Conversion - New Log Grading System

1. Field division — Forest Products.

2. Work project — Timber harvesting and conversion.

3. Line project — Conversion - new log grading systems.
   A. For pine region timber.
   B. For redwood region timber.

4. Purpose — To construct log grading rules for the timber of the respective regions based upon significant criteria visible in the standing tree so sharply and clearly distinguished as to permit the grading to indicate within usably close margins what the log will cut out in lumber grades and values. There have been no recognized log grades in the redwood region. In the pine region under the 3-grade system significant log qualities overlap or are confused in such a way that there is no necessary consistency between the log grade and what it will cut out in lumber grades. A grading which would permit such a correlation would be a great boon to lumbering and forestry.

5. Review of past work — The detailed studies of log character and of lumber grades and values cut out of the logs studied in the logging and sawmill studies, early seemed to indicate the possibility of constructing, from the data of these studies, a system of log grades which would meet the above need at least better than the grades now in use. Constant attention therefore paid to this aspect in all subsequent work, making detailed diagrams and descriptions, and taking pictures of thousands of logs, tied in with the records of lumber grades obtained. All pertinent data have been assembled, classified and subjected to special analysis to this end, and log grades built up, tested, improved. Report on log grades for pine region issued July 1939. Log Grading Conference held with other Stations, Regional Offices, Washington Office, Forest Products Laboratory and industry, in November 1939, resulting in formation of recommended standard log grading for ponderosa pine to apply over its entire range. Work continued collateral to primary studies furnishing data. Practically all logging and sawmill studies made have contributed data. From the earliest ones the logs are being regraded in accordance with present grades and the grade production recomputed, so as to increase the spread of forest sites represented in the data. Redwood data inadequate yet in sites represented, for any formal report.

6. Accomplishments during past year — Analysis of data from 1939 woods and mill study on trees from one of Blacks Mountain cutting plots indicates that the value of a log is affected by the quality of the adjacent logs in the tree. This may be of importance in evaluating particularly the high grade butt logs in standing trees.

New recommended standard log grades for ponderosa pine checked against data from former studies and found to be in need of adjustment, particularly in Grade 2.

7. Plans for next year — Check new standard grades in current studies, and recast data on former studies on new basis if found satisfactory in order to put them on a comparable plane. Will continue collection of redwood data for use in formulating redwood log grades.

8. Date of completion — Redwood study and analysis during 1941.

9. Assignment — Ericksen, Garland.

RP-CAL
TIMBER CONVERSION
Logging and Milling
Blacks Mountain Experimental Forest January 1941

Logging and Milling Studies in Connection with Silvicultural Selection Cutting on Blacks Mountain Experimental Forest

1. Field division — Forest Products.

2. Work project — Timber harvesting and conversion.

3. Line project — Logging and milling studies in connection with silvicultural selection cutting on Blacks Mountain Experimental Forest.

4. Purpose — Determination of costs and realization from harvesting eastside pine, Sites III and IV, according to various methods of cutting. Devising new logging practices to reduce damage. Testing new equipment.

5. Review of past work — Experimental Forest logging project started 1937. Forest Products cooperated with Pine Management in purchase of new equipment, organizing operation, preparing contract for sale of logs, scaling, log grading, planning procedure, and general supervision. Evaluated 925 individual trees on sample marking plot based on log grades and Fruit Growers Supply Company 1934 study data. Loss in lumber values from insects during last three years was $20 an acre on the plot. Made special studies of and reports on performance of logging trucks, loading crane and railroad loader, specifying improvements to be made by manufacturer. Mill studies of Blacks Mountain logs, all lumber surfaced, conducted, and appraisals made on basis of log grades. Mill study made in 1939 to determine relative value of lumber from trees of different insect risk classes.

6. Accomplishments during past year — Remaining data on dry lumber from 1939 mill study collected, analysis and report completed. Trees on three cutting plots of 1940 series logs graded to provide stand structure information for valuation purposes. The results of the 1939 mill study indicate that high insect risk trees were not necessarily high value trees, in fact in the small sample included in the study the high risk trees were of lower average value than those classified as less susceptible to attack. Before any definite conclusions can be drawn, however, it will be necessary to secure data on a larger sample and from other areas.

7. Plans for next year — Studies by Products in connection with various phases of the Blacks Mountain Experimental Forest will continue throughout the first cutting cycle, estimated to take from 12 to 15 years. Mill study will be made next year. Appraisal of cutting systems will be revised on basis of more complete data thus provided. Data from 1939 study will be checked to determine if there is a consistent relationship between tree value and grade of lower logs in the tree. Continue log grading of trees on experimental cutting plots.

8. Date of completion — Continuing project.

9. Assignment — Ericksen, Garland.

RP-CAL
TIMBER CONVERSION
Logging and milling
Insect-infested tree salvage

January 1941

Conversion - Salvage Cutting of Insect-infested Pine

1. Field division — Forest Products.

2. Work project — Timber harvesting and conversion.

3. Line project — Conversion - salvage cutting of insect-infested timber.

4. Purpose — Determination of lumber values recovered from ponderosa and Jeffrey pine bug-trees with relation to kind of infestation and elapsed time since attack.

5. Review of past work — Study made in 1935 on Fruit Growers Supply Company operation in cooperation with Bureau of Entomology and Regional Office on value before and after insect infestation showed that rapid deterioration from blue stain following larval development leaves little chance for profitable salvage unless harvested immediately after infestation, except for trees attacked by flatheads only. Report issued. Application made in new method of attack on bug-tree problem at Blacks Mountain Experimental Forest by confining first cut largely to trees appearing most susceptible to insect attack.

6. Accomplishments during past year — No work of importance.

7. Plans for next year — No specific studies scheduled. As further studies are needed in connection with insect control work, the Products Division plans to cooperate in them with other interested organizations.

8. Date of completion — Continuing.

9. Assignment — Ericksen, Garland.

RP-CAL
TIMBER CONVERSION
Logging and milling
Pine region

January 1941

Conversion - Depreciation in Seasoning Surfacing and Handling Lumber, Pine Region

1. Field division — Forest Products.

2. Work project — Timber harvesting and conversion.

3. Line project — Conversion - depreciation in seasoning, surfacing and handling lumber, pine region.

4. Purpose — To compile and present in systematic form the data on effects of such depreciation, grade by grade, upon the lumber produced and upon its value, as shown by the analyses made in the logging and sawmill studies conducted by this Station, and in convenient form for all work agencies. It has largely been assumed in studies conducted elsewhere that a blanket degrade percent could be applied for these factors. Our studies show that this assumption is erroneous and that the error is of sufficient magnitude that it may entirely invalidate conclusions reached.

5. Review of past work — Detailed data on depreciation due to the operations named have been taken in all the logging and sawmill studies conducted by this Station, under the fear that a blanket percentage depreciation allowance was fallacious. Analysis has verified this fear.

6. Accomplishments during past year — Data being secured covering these phases in 1940 second-growth pine study.

7. Plans for next year — Complete and incorporate data and analyses from second-growth pine study. Secure similar data on studies conducted during year.

8. Date of completion — Data on 1940 study, during 1941.

9. Assignment — Ericksen, Garland.

RP-CAL
TIMBER CONVERSION
Logging and milling
Pine region

January 1941

Logging and Milling Studies in California Pine Region

1. Field Division — Forest Products.

2. Work Project — Timber harvesting and conversion.

3. Line Project — Logging and milling studies in California pine region.

4. Purpose — Determination of logging and milling costs for different species in pine region, different sizes, classes and values of logs and trees on different timber sites, and returns under different cutting systems. To provide data for preparing log grading rules. To furnish up-to-date data for Forest Service Timber Management and to stimulate better forestry practice on private lands.

5. Review of Past Work — Series of studies completed and results reported as bulletins or mimeographed reports.

a. Stanislaus study (Pickering Lumber Co. cooperating, 1929) high Site I, westside. Results published as Bul. 549 by Cal. Agr. Exp. Sta. 1933.

b. Fruit Growers Supply Co. 1931. Special study of white fir milling and seasoning degrade. Office report. Forest Service scaling practice changed.

c. Clover Valley Lumber Co. 1932-33. Special study of white fir. Office reports.

d. Fruit Growers Supply Co. 1934. Logging, milling and seasoning degrade. Eastside Sites III and IV. Established that 46-inch trees gave highest net return, larger trees deteriorated in quality, and trees under 20 inches were submarginal in value. As a result of study, cooperating company changed marking practice, leaving more trees of smaller sizes, up to 26 inches. Data used in evaluating over 1,000 trees on Blacks Mountain Experimental Forest sample marking plot. Also in preparing Part II of Manual. Study and report made in connection with field work on Dow power felling saw. Progress reports for Regional Office of Timber Management, Western Pine Association and lumbermen.

e. McCloud River Lumber Co. 1935. Intensive valuation study on 100 selected small trees, usually poorly represented in virgin stands, Site II. Lumber graded green, rough dry, and surfaced. Showed significant differences in degrade by log and tree classes, and need for extending studies to include dry surfaced lumber depreciation losses, to show true intrinsic values of various tree classes. Mimeographed report issued.

f. Meadow Valley Study - 1937-38. Undertaken at request of R. O. Division of Timber Management to furnish data on westside Sites II and III. Study contributed to fund of data on sites noted and valuable in setting up new log grades.

g. Consolidation and compilation of data from all studies, eastside and westside, into form most useful to forest administration.

h. Fruit Growers Supply Co. (1934) and Meadow Valley study data abstracted and analyzed, and results incorporated in office report on Log Grading Classification issued July 1939.

6. Accomplishments during past year — Mill study of second-growth ponderosa pine conducted at Diamond Match Co., Stirling City, in cooperation with Regional Office, State Division of Forestry, and with assistance from two national forests and Station Division of Economics. Green grade compilation completed.

7. Plans for next year — Collect data on air dry lumber from 1940 second-growth study, complete analysis and report.

If recommended standard log grades for ponderosa pine are accepted, data from above studies will be reanalyzed on basis of standard grades.

8. Date of Completion — 1941.

9. Assignment — Ericksen, Garland.

RP-CAL
TIMBER CONVERSION
Logging and milling
Manual of study procedure January 1941

Conversion - Logging and Milling
Manual of Field and Office Procedure
for Logging and Sawmill Studies

1. Field division — Forest Products.

2. Work project — Timber harvesting and conversion.

3. Line project — Conversion - logging and milling. Manual of field and office procedure for logging and sawmill studies.

4. Purpose — Principally to inform California operators of simple procedures adapted to making logging and milling studies and in analyzing the data therefrom so that they may be encouraged to conduct studies of their own. Secondarily for the information of students or others interested in the details of investigative methods thus far employed in evaluating logs, trees, cutting systems, etc. Many different analytical processes have been used by different workers, comparisons of which show appreciable differences in results from same field data. Evolution still active in this methodology but California lumber operators are urgently asking for guidance now, suited to the California problem, without waiting for definitive, better methods.

5. Review of past work — Part I on Field Procedure was published in multilith form December 1935. Part II, Office Procedure, will utilize data from many sources but mainly from Fruit Growers Supply Company study of 1934. Analysis and organization nearly all data needed is completed. Much of text completed and reviewed by Brundage, although somewhat delayed by need for handling by correspondence. Publication further delayed by resignation of Orr, and completion data indefinite.

6. Accomplishments during past year — No active work on project.

7. Plans for next year — No active work planned.

8. Date of completion — Indefinite.

9. Assignment — _____

RP-CAL
TIMBER CONVERSION
Logging and milling
Redwood region

January 1941

Logging and Milling Studies in the Redwood Region

1. Field division — Forest Products.

2. Work project — Timber harvesting and conversion.

3. Line project — Logging and milling studies in the redwood region.

4. Purpose — To determine the comparative values of lumber yielded by various classes of trees occurring in virgin redwood stands, and the sawmilling costs incident to each class. Data to be coordinated with logging output studies made by Division of Redwood Management for analysis of relation between net income and different degrees of selective cutting. To provide data for formulating redwood log-grading specifications.

5. Review of past work — a. Dolbeer & Carson Lumber Company Study, 1935. Green lumber production from 583 redwood logs, chiefly from Henry Creek plot, 79 acres, established by Station and Regional Office to test feasibility of partial cutting in dense virgin stand. Necessary to formulate log grading rules because none had been established for redwood. Mimeographed reports issued 1936 on relative log values. Curved average selling values per M b.m. green lumber from $20 for 20-inch Grade 3, to $36 for 90-inch Grade 1 logs (1936 basis).

b. Hammond Lumber Company Study, 1936. Green lumber production study on special run of 100 small and medium logs, 18- to 50-inch diameter. To determine merchantability. Station cooperation requested by company. Majority turned out to be merchantable. Office report prepared.

c. Division of Redwood Management's data on logging costs combined with data from mill studies mentioned above and mimeographed report issued showing greatest net returns per annum would be realized by cutting only trees 70 inches and larger in diameter, and greatest returns per acre by cutting only trees 40 inches and larger. Margins per M b.m. for stumpage and profit were $11.23 and $9.96, respectively. Results presented at Redwood Logging Conference. Further office work in log-grade specifications showed that reliable rules cannot be formulated without more studies.

6. Accomplishments during past year — No work on this project in 1940. At company's request study begun with Rockport Redwood Company in cooperation with Regional Office and Division of Forestry, University of California, but dropped before logs went through the mill due to unfavorable weather conditions and failure of company to notify us when ready to saw logs.

7. Plans for next year — Conduct study at suitable locality to provide needed additional information on tree values and for use in building log grades. To include, if possible, depreciation in seasoning.

8. Date of completion — Conduct study during 1941.

9. Assignment — Ericksen, Garland.

RP-CAL
TIMBER CONVERSION
Utilization
White fir

January 1941

Conversion - Production and Utilization of White Fir

1. Field division — Forest Products.

2. Work project — Timber harvesting and conversion.

3. Line project — Conversion - production and utilization of white fir lumber.

4. Purpose — Determination of facts pertaining to the cutting, sawing, seasoning, primary remanufacture, marketing, and present uses of white fir, with special attention to possibilities of improving the returns from the products or of finding new uses, which will overcome the prevailing operating loss on this species.

5. Review of past work — Division of Products cooperated with Forest Products Laboratory in gathering data on white fir manufacture, resulting in government bulletin published under joint authorship February 1934, covering uses, properties, etc. Much prejudice has been engendered by poor manufacture, insufficient seasoning, and improper use. One of main reasons for loss to operators, however, is large amount of defect in white fir trees. Some small mills with low overhead costs have made money on this species, but most large operators leave it standing. In fir types latter practice deteriorates the stand. Special depreciation studies of white fir made by Products at Fruit Growers Supply Company, Clover Valley Lumber Company and Sugar Pine Lumber Company mills. Small chance now to utilize the species for pulp account high hauling costs if logs taken to tidewater, stream pollution if pulped in mountains.

6. Accomplishments during past year — Box manufacturers interviewed during 1940 in connection with general survey of utilization problems, emphasized tendency of white fir to check and to split in nailing, also that citrus shippers prefer pine containing knots to clear white fir. Some white fir used in center sections of three-piece box ends. One manufacturer felt that white fir would be used more as virgin ponderosa pine becomes cut out.

7. Plans for next year — No specific work planned.

8. Date of completion — A continuing intermittent project, mainly in connection with lumbering studies at present.

9. Assignment — Ericksen.

RP-CAL
TIMBER CONVERSION
Utilization

January 1941

Timber Conversion - Utilization

1. Field division — Forest Products.

2. Work project — Timber harvesting and conversion.

3. Line project — Utilization - species and products.

4. Purpose — To assist in the utilization of various species and products through study of their properties, form and quality, and supply as related to use requirements. Two current examples are chinquapin recently cruised in considerable quantities by the R. O. on the Klamath National Forest, and the question of use of burls from California shrubs for smoking pipes, interest in which has revived due to closing off of European sources of supply. In such work it is planned to request the cooperation of the Forest Products Laboratory, particularly on phases involving physical and mechanical properties, working qualities, etc.

5. Review of past work — Little work has been done along this line for a number of years. At the time of the last war some work was done on use of burls, especially Ceanothus for smoking pipes, in cooperation with the Forest Products Laboratory. The Laboratory has made tests on mechanical properties of many of our local hardwoods but information is needed on seasoning, sizes, and grades of lumber that they will yield, and on the quantities available. On this latter phase the Forest Survey Division will be consulted.

6. Accomplishments during past year — None.

7. Plans for next year — Investigate burl sources, quality, and supply. In cooperation with Forest Products Laboratory study seasoning characteristics of chinquapin and utilization possibilities.

8. Date of completion — Continuing project. Above studies during 1941.

9. Assignment — Ericksen.

RE-CAL
FOREST SURVEY
Maps

January 1941

Experimental Inventory

1. Field division — Forest Survey.

2. Work project — Survey of forest resources.

3. Line project — Experimental inventory.

4. Purpose — To develop a plan for conducting a regional timber volume inventory to determine the quantity, kinds, quality, and availability of the standing timber together with the rate of growth and depletion.

5. Review of past work — Field work on an experimental line-plot survey of Bidwell Bar quadrangle (500,000 acres of timber) completed and timber volumes calculated. Techniques developed for classifying density of stocking and age-class structure of timber and cordwood stands. Preliminary plan for region-wide inventory partially completed.

6. Accomplishments during past year — Density of stocking and age-class structure classifications further tested by field sampling of additional areas, from aerial photos representing a cross section of the Sierra Nevada.

7. Plans for next year — Complete plan for inventory of 9,000,000 acre cross section of Sierra Nevada Mountains region. Initiate survey if funds for this purpose are made available July 1.

8. Date of completion — 1941 (Plan only)

9. Assignment — Wieslander, Jensen, Burks, Wilson.

RE-CAL
FOREST SURVEY
Maps

January 1941

Forest Condition Map

1. Field division — Forest Survey.

2. Work project — Survey of forest resources.

3. Line project — Forest condition map.

4. Purpose — To prepare a map supplementing the vegetation type map and regionwide in scope so far as forest and potential forest land are concerned, showing age class and stocking conditions and productivity for growing timber.

5. Review of past work — a. Field work completed for 74 15-minute quadrangle units.

b. Negatives for blue-line printing and coloring prepared for 38 15-minute quadrangle units.

c. Modified classifications based on aerial photographs developed.

6. Accomplishments during past year — Negatives prepared and blue-line prints colored for 38 15-minute quadrangle units.

7. Plans for next year — Prepare negatives for remaining 36 15-minute quadrangle units covered by field survey.

8. Date of completion — Will be completed simultaneously with the vegetation type map.

9. Assignment — Wieslander, Jensen, Burks, Wilson.

RE-CAL
FOREST SURVEY
Maps

January 1941

Ecological Studies

1. Field division — Forest Survey.

2. Work project — Survey of wild land resources.

3. Line project — Ecological studies.

4. Purpose — To increase the usefulness of the vegetation type maps for land use planning and other purposes by the analysis and correlation of the distribution of various species and types with climate, soil and the effect of fire and other land abuse.

5. Review of past work — Mainly groundwork data compilation as follows:

(a) Southern California: 49 species distribution maps completed. Isohyetal map constructed, geological and fire history maps partially completed.

(b) Santa Cruz Mountains region: Vegetation and soils compiled for 23 mile transect, vegetation and forest resource maps completed, fire and lumbering history data collected.

(c) Statewide bibliographical research: 23,000 items on lumbering, fires and vegetation.

6. Accomplishments during past year — Under (b) above vegetation-soil transect data carded and summarized preparatory to analysis; under (c) 6,400 items abstracted and indexed.

7. Plans for next year — Under (b) Santa Cruz: Analyze data and prepare 2 papers for publication on (1) results of vegetation-soil transect study and (2) effect of fire and lumbering on vegetation types, and under (c) Statewide bibliographical research will continue on past basis.

8. Date of completion — Indefinite.

9. Assignment — Wieslander, Jenson, Wilson.

RE-CAL
FOREST SURVEY
Maps

January 1941

Herbarium

1. Field division — Forest Survey.

2. Work project — Survey of wild land resources.

3. Line project — Herbarium.

4. Purpose — To preserve a collection of native plants (1) for authenticating all plants recorded on the vegetation maps and sample plots and (2) of value for taxonomic, genetic, and ecological studies.

5. Review of past work — 24,474 specimens determined, mounted, and catalogued. Technical Note #8, 3 papers and 1 note published in technical journals.

6. Accomplishments during past year — 501 specimens determined, mounted, and catalogued. Three papers (2 Arctostaphylos and 1 Helianthemum) published.

7. Plans for next year — Continue research on Arctostaphylos; prepare and publish as technical note, field keys and charts of the shrubby genera of the Compositae of California and western Nevada. Compile on maps distribution of important trees and shrubs from type maps, sample plots, and herbarium specimens.

8. Date of completion — Continuing project for duration of vegetation type survey.

9. Assignment — Wieslander, Burks.

RE-CAL
FOREST SURVEY
Maps

January 1941

Vegetation Type Map

1. Field division — Forest Survey.

2. Work project — Survey of wild land resources.

3. Line project — Vegetation type map.

4. Purpose — To prepare a vegetation type map for the wildlands of California and western Nevada as a basis for land use studies and policies; rating fire hazard and planning fire control; and for application of research pertaining to many phases of wildland resource management.

5. Review of past work — Extensive data collected in reconnaissance survey begun in 1926 from which statewide natural cover and land use map compiled in 1934. Progress in subsequent intensive mapping of regionwide area of 72 million acres as follows: Field mapping 45 percent, office compilations 37 percent, map-unit negatives prepared for blue-line printing pending publication 52 (11 percent), map units published 21 (9 percent), in process of publication 3 (1 percent), and submitted for drafting work prior to publication 8 (2.7 percent). Release #1 published on results of survey for Santa Cruz Mountains region, with two others (western Nevada and Los Angeles and San Bernardino Counties) nearly completed. Techniques and classifications developed for mapping with aerial photographs in 30-square-mile experimental survey.

6. Accomplishments during past year — Map-unit negatives for blue-line printing 52 (11 percent). Map units published 1 (1 percent).

7. Plans for next year — (1) Continue preparation of type maps and their publication. (2) Prepare 2 and publish 4 releases on vegetation type phase of Forest Survey. (3) Prepare for multilith publication report on techniques and classifications used in type mapping from aerial photographs.

8. Date of completion — Continuing project.

9. Assignment — Wieslander, Jenson, Burks, Wilson.

RE-CAL
FINANCIAL ASPECTS
Private forestry January 1941

Financial Returns and Utilization Conditions in Second-growth Timber

1. Field division — Forest Economics.

2. Work project — Private forestry.

3. Line project — Financial returns and utilization conditions in second-growth timber.

4. Purpose — To determine utilization conditions and the factors affecting costs and returns for second-growth timber production in the Sierra Nevada foothills.

5. Review of past work — Begun in 1938. Data assembled on area of second-growth forest lands, sites, stand volumes and composition, mortality, growth rates, and quality of second-growth lumber. Manufacturing practices, lumber and stumpage prices, and production costs determined by field and office studies. A logging and milling study in second-growth timber revealed variations in costs and values by tree diameters. Study of sample property made to determine potential income from selective timber management. Field data analyzed and report prepared.

6. Accomplishments during past year — Manuscript prepared for publication as Agricultural Experiment Station bulletin. Supplemental survey initiated, completed and report prepared on marketing conditions for west slope Sierra second-growth timber. Survey indicated indifferent future for low-grade second-growth lumber, but reasonably encouraging future for piling and veneer. These conditions may encourage silviculture and growing of quality wood. Survey of especial value to county farm advisors and others interested in farm forestry.

7. Plans for next year — a. Revision by Josephson of manuscript on financial returns and submission for publication.

b. Revision of report on marketing conditions and publication of article thereon.

8. Date of completion — 1941.

9. Assignment — Crafts, and Josephson (Department of Forestry, University of California.)

RE-CAL
STATISTICS
Lumber production January 1941

Lumber Census
(In cooperation with U. S. Bureau of the Census.)

1.	Field division	Forest Economics.
2.	Work project	Forest Products statistics.
3.	Line project	Lumber, etc., census.
4.	Purpose	To collect, edit, and record for the Bureau of the Census data on the production of lumber, lath, shingles and other forest products; and for the Forest Service, data on stumpage prices, log prices, and lumber distribution.
5.	Review of past work	A standardized project of long standing.
6.	Accomplishments during past year	Canvass made as usual.
7.	Plans for next year	Continue as usual.
8.	Date of completion	Continuing project.
9.	Assignment	Ericksen, Miss F. Gruenewald.

RE-CAL
NEW PUBLIC DOMAIN
California
N. Sierra Nevada Foothills

January 1941

Land Utilization in the Northern Sierra Nevada Foothills
(In cooperation with the Forest Survey and
the University of California)

1. Field division — Forest Economics.

2. Work project — New public domain.

3. Line project — Land utilization in the northern Sierra Nevada foothills. A cooperative project with the Giannini Foundation of Agricultural Economics and the Department of Forestry, University of California.

4. Purpose — To determine extent, location and interrelationships among natural resources; past and present patterns of land use; land use problems, and conflicts among uses; changes in private and social incomes from land use adjustments; and the probable effect of policies designed to improve land utilization.

5. Review of past work — Begun in 1933. Data on natural resources and past and present utilization patterns collected and analyzed. Map series completed.

6. Accomplishments during past year — Manuscript prepared for publication as Agricultural Experiment Station bulletin.

7. Plans for next year — Final revision of manuscript and publication.

8. Date of completion — 1941.

9. Assignment — Crafts, in cooperation with Hill, Wieslander; Weeks (Giannini Foundation) and Josephson (Department of Forestry, University of California).

RE-CAL
RANGE ECONOMICS
General

January 1941

Range Insurance

1. Field division — Forest economics.

2. Work project — Range economics.

3. Line project — Range economics. Range insurance for the ranch operator.

4. Purpose — To appraise the possibilities and to develop a practical plan of range insurance that will protect the operator from severe losses in forage productivity and grazing capacity as a result of drought. Report to be submitted to University of Michigan in partial fulfillment of requirements for doctorate in Forest Economics.

5. Review of past work — None. Started in 1940.

6. Accomplishments during past year — Field and office data assembled and partially analyzed. Literature searched. Preliminary draft of report partly prepared. Southwest selected as study region. However, insurance technique involved may apply to other regions. The insurance aims to indemnify the insured for extra expense incurred as a result of extreme fluctuations in forage crop occasioned by drought. Such expenses might be in the form of purchase of feed, forced sales at low prices, or shipment of animals to distant pasture. The policy planned is a valued one and the insured could get coverage within certain limits at so much per animal unit of grazing capacity. Five types of coverage may be offered, involving memorandum, deductible average, and other modifying clauses. Tentative indications from a number of test cases are that net premiums will vary depending on location and type of coverage from .05 to 7.5 percent of the policy face value. Gross premiums will include loading for range inspection, other expenses, and safety factor. Insurance protection based on grazing capacity and proper utilization would be a great inducement for the insured to practice good range management.

7. Plans for next year — Continue data analysis and preparation of report.

8. Date of completion — 1942.

9. Assignment — Crafts, in cooperation with range research division, and Southwestern Station.

RI-CAL
STREAMFLOW
Forest

January 1941

Relation of Forest Cover to Streamflow
Kings River Branch - Teakettle Creek Unit
Fir-Pine

1. Field division — Forest and Range Influences.

2. Work project — Influence of natural vegetation on streamflow.

3. Line project — Forest - relation of forest cover to streamflow. Kings River Branch - Teakettle Creek Unit.

4. Purpose of work — To study precipitation, run-off, ground-water, and erosion in relation to topography, geology, soil, vegetation and fauna in mountain areas by means of comparable watersheds typical of high Sierra region in San Joaquin Valley.

To determine methods of managing watersheds in representative fir and fir-pine types of Sierra Nevada (tributary to San Joaquin Valley) for maximum beneficial yield of water consistent with satisfactory control of floods and erosion and with other legitimate uses of the forest. Precipitation chiefly snow.

5. Review of past work — Three 500-acre watersheds were selected in 1934 in headwaters of Teakettle Creek between elevations 6,000 to 8,000 feet. The area is tributary to North Fork of Kings River, Sierra National Forest, 75 miles from Fresno. Topographic map completed in 1935 and geological study including map and report in 1936. Facilitating improvements completed include 3 gaging stations with dams for erosion measurements, 3 shelter cabins, 1 warehouse, 8 miles roads, 2 miles telephone lines, 25 miles of trails marked with 1500 snow markers and a domestic water system with 30,000 gallon reservoir. Collection of records started during 1939 including surveys of two snow courses.

6. Accomplishments during past year — Precipitation, temperature and run-off records were continued throughout the year on three watersheds including periodic surveys of snow courses. Twelve additional snow courses were laid out and mapped. Improvements completed with assistance of WPA were: 1 gaging station with dam and debris reservoir, 4 ground water observation wells, 1 snow-soil temperature station and numerous minor facilitation improvements.

7. Plans for next year — Continue collection of data with additional snow observations as personnel permits.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Sinclair, with technical assistance of other staff members as required.

RI-CAL
STREAMFLOW
Forest

January 1941

Relation of Forest Cover to Streamflow
Bass Lake Run-off and Erosion Plots

1. Field division — Forest and Range Influences.

2. Work project — Influence of natural vegetation on streamflow.

3. Line project — Forest - relation of forest cover to streamflow. (Second-growth ponderosa pine. Bass Lake run-off and erosion plots.)

4. Purpose — To study the influences of second-growth ponderosa pine stands on surface run-off, erosion, and water yield.

5. Review of past work — Established in 1934; installation comprised of six 1/40-acre plots, placed in triplicate in 60- to 80-year-old second-growth ponderosa pine stand, near Bass Lake, Sierra National Forest. All plots operated without disturbance of vegetation cover during a 4-year calibration period. On one set of three plots, ground cover of litter and herbaceous vegetation has been burned off annually since fall of 1938 to study effect of light ground fires on surface run-off and erosion. Prior to burning of litter cover and herbaceous vegetation there was no erosion and surface run-off from the plots averaged less than 1 percent of total precipitation.

6. Accomplishments during past year — During 1939-40 season characterized by a lack of high intensity rainfall there was approximately 51.9 inches of precipitation. Over 3 percent of the precipitation ran off the burned plots and produced erosion at the rate of nearly 1/4 ton per acre. From the undisturbed plots there was only about 0.2 inch depth of run-off and no erosion. Needle fall from pines after burnings has afforded a fairly good ground cover before the occurrence of first winter rains.

   Meteorological installations have been enlarged and improved, and a portable house to serve as living quarters for operators during storm periods has been erected during past season.

7. Plans for next year — Plot studies to be continued without change in procedure for at least one more season.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Rowe, Daniel.

RI-CAL
STREAMFLOW
Shrub cover

January 1941

Relation of Chaparral Cover to Streamflow
San Dimas Experimental Forest

1. Field division — Forest and Range Influences.

2. Work project — Influence of natural vegetation on streamflow.

3. Line project — Chaparral - relation of chaparral cover to streamflow - San Dimas Experimental Forest.

4. Purpose — To evaluate factors of precipitation, streamflow, ground water and erosion, and to study their relationship to topography, geology, soil, vegetation and fauna on certain watershed units in southern California.

To determine methods of watershed improvement and management in typical chaparral forest cover of southern California for the maximum yield of useful water consistent with conservation and satisfactory control of floods and erosion.

5. Review of past work — Initiated in 1932. Experimental area embraces 17,000 acres of San Dimas and Big Dalton drainages within the Angeles National Forest tributary to San Gabriel River. Observations being made on 17 watersheds varying from 35 to 10,200 acres each. Installations include: 317 raingages, of which 23 record intensity, 7 meteorological stations, 17 streamgaging stations, and 9 reservoirs for erosion measurements. Two Los Angeles County flood control dams are used cooperatively as controls. Detailed surveys of vegetation, fauna, and geology of the Forest started. Vegetation type map of Bell and Fern watersheds completed and 14 phenological plots established. Succession studies started in Fern Canyon burn immediately following 1938 fire. Forest herbarium includes about 450 species: collection of birds and animals numbers more than 150 species. Detailed geologic surveys of Bell and Fern watersheds completed and geology of Big Dalton drainage mapped.

Publications: "Measurement of debris-laden streamflow with critical-depth flumes", by H. G. Wilm, J. S. Cotton and H. C. Storey. Trans. Amer. Soc. Civ. Eng., 1938. "An analysis of precipitation measurements on mountain watersheds", by H. G. Wilm, A. Z. Nelson and H. C. Storey, Monthly Weather Review, June 1939.

Manuscripts: "Topographic influences on precipitation", by H. C. Storey, Sixth Pacific Science Congress, August 1939. "San Dimas streamgaging flume - a code for installation and operation", S. M. Munson, Karl J. Bermel and H. C. Storey, CF&RES Research Note No. 22.

6. Accomplishments during past year — All research installations operated. Data tabulated and summarized through 1939-1940 season. Average seasonal precipitation by watersheds varied from 25 to 34.6 inches with surface run-off for season ranging from less than 1 percent to 10.4 percent of precipitation. Maximum flows very moderate. Influence 1938 burn Fern Canyon evident in peak flow from that watershed.

Watershed X(Monroe) selected as unit on which to concentrate completion of field inventories and surveys with detailed analysis of all data and work started.

Preliminary results from study of various types of raingages and methods of exposure indicate most reliable rainfall measurements obtained from 8-inch gage with top flush and parallel to ground surface if ground covered with brush or screen for 3 feet radius to prevent splash.

Succession and phenological plot observations continued and plot data summarized. Forest herbarium and seed collection enlarged and identification checked.

Soils inventory started by taking depth measurements at 1/4-mile intervals on raingage trails. Initiated periodic soil moisture sampling at five locations in Monroe watershed.

Circulating flume installation for study of effect of bedload upon rating of San Dimas flume completed at Berkeley in cooperation with University of California.

Improvements made with assistance of CCC and WPA include:

1. Flood control measures in Fern Canyon burn completed.
2. Three large streamgaging stations remodeled.
3. Suppression and maintenance crew barracks constructed at Tanbark Flat.
4. Glendora headquarters buildings completed.

Manuscript prepared, "The sample plot as a method of quantitative analysis of chaparral vegetation in southern California" by J. S. Horton.

Publications: "The San Dimas Experimental Forest" by C. J. Kraebel and J. D. Sinclair, Transactions American Geophysical Union, 1940. "San Dimas Experimental Forest" by E. L. Hamilton, Southern California Social Studies Review, October, 1940.

7. Plans for next year — Present research installations to be continued and records summarized. Analysis of hydrologic and other records to be made with emphasis on completion of data from Watershed X (Monroe).

Study of several types of raingages to be continued and data analyzed.

Influence of bedload on rating of San Dimas flume to be studied at Berkeley in cooperation with University of California.

Surveys of watershed areas and physiographic features to be continued. Inventories of geology, soils and vegetation to be carried forward. Continuation of studies on quantitative composition of typical chaparral, succession and phenological plots.

In addition to regular maintenance facilities, planned improvements include:

1. Two large streamgaging stations to be remodeled.
2. Domestic and fire protection water systems at Tanbark Flat to be improved.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Sinclair, Hamilton, Storey. San Dimas flume studies - Berkeley: Storey.

RI-CAL
STREAMFLOW
Shrub cover

January 1941

Relation of Chaparral Cover to Streamflow
Barranca Watershed

1. Field division — Forest and Range Influences

2. Work project — Influence of natural revegetation on streamflow.

3. Line project — Chaparral - relation of chaparral cover to streamflow - Barranca.

4. Purpose — To develop methods of measuring debris-laden flows and to study rainfall - run-off relationships and the development of chaparral during regrowth after fire.

5. Review of past work — A debris-catchment reservoir, streamflow measuring equipment, 7 rain gages and 36 milacre quadrats were established on this 44-acre watershed in 1927, two years after denudation by fire. Weirs, Parshall flumes and tipping bucket installations proved inadequate as means of measuring flashy debris-laden run-off resulting in incomplete records, but erosion deposits have been measured annually in reservoir. (See Relation of Forest, Brush and Grassland Cover, Erosion and Soil Stability, State-wide.)

   A 3-foot San Dimas flume installed at gaging station furnished a continuous measurement of the debris-laden streamflow which occurred during the flood in March 1938.

6. Accomplishments during past year — Raingages and streamgaging station maintained and quadrat data summarized to date. For erosion measurements refer Intensive Erosion Measurements and Surveys, State-wide.

7. Plans for next year — Instruments to be maintained and records collected on run-off, erosion, rainfall and vegetation. If personnel permits, past records will be analyzed for a progress report.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Sinclair, Storey, Weaver.

RI-CAL
STREAMFLOW
Woodland

January 1941

Relation of Woodland Cover to Streamflow
Kings River Branch - Big Creek Unit

1. Field division — Forest and Range Influences

2. Work project — Influence of natural vegetation on streamflow.

3. Line project — Woodland - relation of woodland cover to streamflow - Kings River Branch - Big Creek Unit.

4. Purpose — To study precipitation, run-off, ground water, and erosion in relation to topography, geology, soil, vegetation and fauna in mountain areas by means of comparable small watersheds typical of the Sierra foothill region in the San Joaquin Valley.

To determine methods of managing watersheds in representative woodland forest type of oak, grass, chaparral and Digger pine in the Sierra foothills for maximum beneficial water yield, consistent with satisfactory control of floods and erosion and with other legitimate uses of the forest.

5. Review of past work — Initiated 1934. Major construction completed 1937 on seven small watersheds (elevation range 1,000 to 2,000 feet) embracing 200 acres on tributaries of Big Creek which enters Kings River 45 miles from Fresno. Area grazed annually during April, May and June. Installations include 100 raingages, 3 meteorological stations, 3 rainfall intensity gages, 9 streamgaging stations, 3 reservoirs for extreme and 5 reservoirs for moderate erosion measurements. Improvements include 5 miles trails, headquarters facilities, 6 miles telephone lines and 1 field shelter cabin.

First complete seasonal records obtained during 1936-37 on 3 watershed units (IV, V, and VI) and collection of data at other stations was started as soon as construction completed. Technical Note No. 11, Kings River Branch, Watershed Study Units, prepared by S. M. Munson.

Geological study including map and report completed.

In December 1937 an extreme storm caused extensive damage within the experimental area through boulder flows. Rehabilitation was completed by July 1938 and included the removal of large deposits of debris, structure repairs, and the revision of structures to protect them against similar damage. All landslides occurring during this storm mapped and volumes of earth movement estimated.

A gaging station was established on Big Creek near the experimental area to provide a record of streamflow from an intermediate watershed approximating 70 square miles in area.

Seasonal rainfall during past four years of record has varied from 16.98 to 42.48 inches with seasonal surface run-off ranging from approximately 3 to 30 percent of the precipitation.

6. Accomplishments during past year — Collection of precipitation, run-off and erosion records continued. Data summarized and progress report prepared by S. M. Munson, October 1940. Infiltration studies conducted on two watersheds and data partially analyzed. Cooperative study with wildlife service started on rodent populations and their relation to run-off and erosion. Four spring flow study installations completed. A new streamgaging station on Big Creek completed and records started. Former Big Creek station discontinued.

7. Plans for next year — Continue collection and compilation of precipitation, run-off, erosion and climatic data and their analysis. Continue vegetation surveys and cooperative study with wildlife service referred to above. Start periodic soil moisture sampling on watersheds to be selected.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Sinclair, with technical assistance of other staff members as required.

RI-CAL
STREAMFLOW
Shrub cover

January 1941

Relation of Chaparral Cover to Streamflow
San Dimas Experimental Forest Run-off and Erosion Plots

1. Field division — Forest and Range Influences.

2. Work project — Influence of natural vegetation on streamflow.

3. Line project — Chaparral - relation of chaparral cover to streamflow.

4. Purpose — To study the influence of typical types of chaparral vegetation on surface run-off and erosion.

5. Review of past work

a. San Dimas series. Elevation 1200 feet, old north slope mixed chaparral, 2 pairs 1/40-acre plots established 1930. Vegetation on one pair undisturbed. Second pair burned annually until 1937, unburned since as succession study.

b. Tanbark Flat series. Elevation 2800 feet, ceanothus-oak-chamise subtype unburned for 19 years, 3 triplicate sets 1/40-acre plots established 1934. Vegetation on all plots undisturbed during calibration period.

Run-off has averaged less than 1 percent of the rainfall with maximum of 2 percent during major storm of March 1938 with only trace of erosion.

c. Fern Canyon series. Elevation 5000 feet, oak-woodland subtype 50-year-old chaparral, 3 triplicate sets 1/40-acre plots established 1934. All plots denuded by forest fire November 1938. Plots treated immediately after fire as follows: 3 left untouched as controls; 3 oak stems felled and placed on ground surface at right angles to slope; 3 sown to mustard.

Maximum run-off before denudation less than 1 percent during storm of March 1938 with no erosion. Following fire maximum run-off approximately 10 percent of precipitation, with erosion up to 2000 cubic feet per acre.

6. Accomplishments during past year — Observations continued on all plots. No changes in treatment. No significant changes in performance on San Dimas and Tanbark series. On Fern Canyon series the vegetation has grown markedly since the burn and run-off rate has decreased from an average of 5.27 percent for 9 plots to 1.16 percent while the erosion decreased from ~~3,000~~ 235 cubic feet per acre to about 17 ~~45~~ cubic feet per acre. Untreated plots show higher run-off and erosion rates than treated plots. Data summarized and tabulated to date. Soil moisture sampling program initiated at both Tanbark and Fern Plots at two locations on each series.

7. Plans for next year — Continue San Dimas series as a succession study only. Continue operation of Fern series under present treatments. Draw up and put in effect plan of treatment for Tanbark Plots. Treatment to consist of silvicultural thinning and clear cutting. Control set of plots to have cut-off wall set at lower end in attempt to measure subsurface flow.

8. Date of completion — Definite date cannot be set for completion of project.

9. Assignment — Kraebel, Sinclair, Rowe, Hamilton.

RI-CAL
STREAMFLOW
Shrub cover

January 1941

Relation of Chaparral Cover to Streamflow
North Fork Run-off and Erosion Plots

1. Field division — Forest and Range Influences.

2. Work project — Influence of natural vegetation on streamflow.

3. Line project — Chaparral - relation of chaparral cover to streamflow. (San Joaquin foothills, chaparral-woodland brush, North Fork run-off and erosion plots.)

4. Purpose — To study the influence of chaparral woodland vegetation on water yield, surface run-off, and erosion.

5. Review of past work — Installation comprises three pairs of 1/40-acre plots established 1929 and two pairs of 1/100-acre plots established 1933. Smaller plots are equipped with a sprinkler system to permit runs employing artificial rainfall. Except for one year, 1930, the vegetation on one pair of 1/40-acre plots was burned annually from 1929 to 1938; on a second pair the vegetation was burned in 1930 and again in 1936; and on a third pair the vegetation has been maintained without burning. The 1/100-acre plots were operated during a 3-year calibration period without disturbance of the vegetation. Following the calibration period one pair of the plots has been denuded annually by burning. During the 9-year period between 1929 and 1938 there were approximately 43 inches of surface run-off on the 1/40-acre annually burned plots, 5.6 inches on the twice burned plots, and 0.1 inch on the undisturbed plots. Corresponding erosion rates were 113 tons, 4 tons, and 0.006 ton per acre, respectively. Results of the smaller plot studies employing both natural and artificially made rainfall have substantiated those of larger plots.

6. Accomplishments during past year — Precipitation for the 1939-40 season, occurring for the most part at very low intensities, was about 41.0 inches, or approximately 8 inches above normal. Surface run-off from the plots burned annually until the 1938-39 season was nearly 2 percent of the total precipitation, from twice burned plots less than 1 percent of the precipitation, and from undisturbed plots none. Erosion rates were 75.0 pounds per acre, 6.0 pounds per acre, and none, respectively.

On the pair of 1/100-acre plots burned for the first time in 1936, the surface run-off was equal to over 5 percent of the precipitation and produced erosion at the rate of approximately 645.0 pounds per acre. On the pair with an undisturbed vegetation cover there was no surface run-off or erosion recorded during the 1939-40 season.

Ten runs employing artificial rainfall at rates ranging from 1.5 to 3.5 inches per hour and totaling 26.7 inches made on the 1/100-acre burned plot resulted in surface run-off equivalent to approximately 64 percent of the precipitation and produced erosion at the rate of over 14 tons per acre. Similar runs made on the undisturbed vegetation plots failed to produce measurable amounts of either surface run-off or erosion.

Results of the first nine years of the study submitted for publication as U.S.D.A. Bull., March 1940.

7. Plans for next year — Precipitation, run-off, and erosion measurements on all plots to be continued without change in treatment, and records summarized. As in the past, the natural rain on the 1/100-acre plots to be supplemented by a series of runs employing artificial rainfall. Results of the smaller plot studies to be prepared for publication during 1941.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Rowe, Daniel.

RI-CAL
STREAMFLOW
Shrub cover

January 1941

Relation of Chaparral Cover to Streamflow
Berkeley Run-off and Erosion Plots

1. Field division — Forest and Range Influences.

2. Work project — Influence of natural vegetation on streamflow.

3. Line project — Chaparral - relation of chaparral cover to streamflow. (Coast brush type, Berkeley, Strawberry Canyon run-off and erosion plots.)

4. Purpose — To study the influence of chaparral vegetation on surface run-off and erosion.

5. Review of past work — Installation comprises 3 pairs 1/60-acre plots established 1932. One pair plots maintained with natural vegetation cover, one pair burned periodically, one pair burned annually. Results to date indicate that reestablishment of vegetation is normally so rapid that repeated denudation only slightly increases surface run-off and erosion.

6. Accomplishments during past year — Precipitation for 1939-40 season 38.74 inches. Surface run-off from annually burned, periodically burned, and undisturbed vegetation plots approximately 4.3 percent, 0.8 percent, and 0.1 percent of total precipitation, respectively; and erosion rates approximately 12.0 tons, 0.05 tons, and 0.04 tons per acre, respectively. This is the first season that surface run-off has occurred at rates sufficient to produce significant amounts of erosion.

7. Plans for next year — Studies to be continued to observe long time effects of annual burning on surface run-off and erosion and to serve as a demonstration unit for visiting scientists and forestry students. Results to be summarized in preparation for publication.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Rowe, Daniel.

RI
WATER UTILIZATION
Shrub cover

January 1941

Consumptive Use of Water by Chaparral Species
San Dimas Experimental Forest

1. Field division — Forest and Range Influences.

2. Work project — Water utilization by vegetation.

3. Line project — Chaparral - consumptive use of water by chaparral species (lysimeter soil moisture, and interception studies).

4. Purpose — To study the influence of native chaparral vegetation on the disposition of precipitation (percolation, transpiration, evaporation, interception, and run-off) under controlled conditions.

5. Review of past work

San Dimas Experimental Forest group. Installed in 1937 and composed of 26 large concrete lysimeters, each 5 milacres in area and 6 feet deep and equipped to measure the intensity of rainfall, percolation, and run-off. Series also includes 102 circular lysimeters equipped with weighing apparatus. Thirty of these small lysimeters have a soil capacity of 1800 pounds and 72 have a soil capacity of 300 pounds. The San Dimas group also includes 5 unconfined lysimeters (soil blocks) each 17½ feet square by 7 feet deep, located in the vegetation border strips and filled with the same soil as the large lysimeters. Observations on the unconfined lysimeters will be made by soil moisture sampling. Installation completed and collection of data initiated with the beginning of the 1937-38 rainy season.

Five concrete lysimeters 4 x 6 feet in size and 6 feet deep, having one removable wall installed for study of root development were completed in 1938. Soil settlement measurements started in large lysimeters, summer 1938 - repeated in 1939. Manuscript: "A lysimeter installation for evaluating the water economy of chaparral" by E. A. Colman and C. J. Kraebel.

6. Accomplishments during past year — Soil settlement measurements made in all lysimeters and report prepared showing annual and total 3-year settlement in all lysimeters. Data from all lysimeters summarized to date and that from large lysimeters partly analyzed. Report prepared entitled "The San Dimas lysimeters - comparative performance 1937-1940" by E. L. Hamilton. As a result of findings shown in both reports, the excess soil originally disposed as overfill to supply weight and volume during settling period, was removed. Soil removed from lysimeters averaged 5.15 tons each from large; 7.96 tons each from unconfined, and 0.85 tons from root study. This removal brought these lysimeters to uniform depth of 72 inches. Soil was added to small and medium lysimeters to replace settlement. Large lysimeters covered with

cheesecloth for mulch and sowed to Bromus mollis except one left unsown for check. Unconfined lysimeters treated similarly except no check. Two and one-half milacre plot in each unconfined unit equipped with run-off catchment trough and tank. Small and medium lysimeters sown with Bromus mollis except four check tanks of each series left bare.

Six large lysimeters equipped with one cubic inch tipping buckets in order to obtain intensive measure of seepage rates. This led to discovery of semidiurnal cycles corresponding to similar barometric changes. Recording system for rainfall, run-off, and seepage improved and extended.

Study of comparative rain catch in low and high-sided trough rain gages indicated that latter catch about 4.5 percent more rain than former.

Average Large Lysimeter Performance

Season	Precip. P (in surface inches)	Run-off R	Seepage S	Water yield (R+S)=Y	R %	S %	Y %
1937-38	47.03	26.26	.43	26.69	55.8	0.9	56.7
1938-39	20.52	7.78	4.06	11.84	37.9	19.8	57.7
1939-40	26.46	14.80	4.08	18.88	55.9	15.4	71.3
3-year total	94.01	48.84	8.57	57.41	52.0	9.1	61.1

Average Soil Settlement in Feet

Type of lysimeter	1937	1938	1939	1940	Total
Large	.09	.38	.07	.03	.54
Unconfined		.44	--	--	.44
Root study			.14	.08	.22
Medium					.45
Small					.16

Before removal of overfill intensive soil tube exploration made in 8 large lysimeters to determine amount and distribution of soil moisture. Moisture sampling program initiated which includes periodic sampling at 10-day intervals in one unconfined lysimeter and occasional sampling in two large lysimeters.

7. Plans for next year — Continue cover of Bromus mollis. Install recording instruments to get run-off rates from unconfined lysimeters. Improve seepage recording instruments. Continue study of seepage cycles. Continue soil moisture measurements. Design and build movable bridge for large lysimeters.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Sinclair, Hamilton, Rowe.

RI-CAL
WATER UTILIZATION
Shrub cover

January 1941

Consumptive Use of Water by Chaparral Species
Berkeley

1. Field division — Forest and Range Influences.

2. Work project — Water utilization by vegetation.

3. Line project — Chaparral - consumptive use of water by chaparral species (Berkeley lysimeters, Oxford Street and Strawberry Canyon).

4. Purpose — To study influence of brush and chaparral vegetation, including mustard cover and various types of forest litter, on disposition of precipitation (interception, infiltration, evaporation, transpiration, percolation, and surface run-off).

5. Review of past work — Oxford Lysimeters. Initiated 1927 with series A of eight lysimeters. Two series, B and C, of five tanks each, added 1931. Series A and C temporarily discontinued 1936. Soil in series B tanks resurfaced July 1933 and sown to Bromus mollis to establish root penetration in upper soil surfaces. In November 1934 grass burned off and a 1¼-inch, 3/4-inch, 1/2-inch, and a 1/4-inch Monterey pine litter cover placed in tanks 1, 2, 3, and 4, respectively. Publications: "Influence of forest litter on run-off, percolation, and erosion," Jour. Forestry, April 1930. "Run-off and erosion experiments in mountain areas," Station mimeographed pamphlet, 1935. Partial results also used in other publications.

Strawberry Canyon Lysimeters. Two series (A and B) of five rectangular lysimeters installed 1931. Individual lysimeters are 80 square feet in area by 50 inches deep. Three tanks of series A filled with Altamount soil collected at site of installation and two filled with Sierra foothill sandy clay loam collected near North Fork. Series A tanks planted to Quercus dumosa in 1933. All five tanks of series B filled with Altamount soil. Planted to Ceanothus cuneatus in 1933. All tanks (Series A and B) operated without treatment until June 1938 to allow vegetation to form complete canopy, when vegetation thinnings were started on series B, as follows: Tank 1, vegetation undisturbed, density 60 percent; tank 2, density of vegetation reduced to 51 percent; tank 3, to 41 percent; tank 4, to 19 percent; and tank 5, completely denuded. Density of vegetation on series A not yet sufficient to permit satisfactory manipulation. Prior to treatment the evaporation-transpiration losses for series B were approximately 3 to 4 inches greater and the total percolation from 3 to 4 inches less than for series A.

6. Accomplishments during past year — Oxford Lysimeters. Rainfall, surface run-off, evaporation, and percolation for 1939-1940 season, installation B, given in the following table:

Factors observed	Tank #1 (1½-inch litter cover)	Tank #2 (3/4-inch litter cover)	Tank #3 (1/2-inch litter cover)	Tank #4 (1/4-inch litter cover)	Tank #5 Bare
Rainfall (Inches)	33.51	28.04[1/]	35.15	35.42	36.41
Surface run-off (Inches)	0.69	0.31	1.28	2.83	7.48
Percolation (Inches)	15.52	10.56	13.66	12.98	7.54
Evaporation (Inches)	17.30	17.17	20.21	19.61	21.39
Erosion (grams)	0.00	0.00	0.00	0.00	17.01

1/ Two storms equivalent to approximately 20 percent total precipitation not included.

Litter cover burned off tanks May 15, 1940, and all tanks except one sowed to black mustard (Brassica nigra). Purpose of study to determine influence of mustard cover on surface run-off and erosion from burned areas.

Strawberry Canyon Lysimeters. Rainfall, oak lysimeters, series A, for 1939-40, was 36.58 inches. Average surface run-off, percolation, and evaporation-transpiration-interception from Altamount soil tanks was approximately 0, 60, and 40 percent of total precipitation, respectively; and from Sierra soil tanks, 2, 62, and 36 percent, respectively. Rainfall, surface run-off, evaporation, and percolation for 1939-40 season, installation B, given in following table:

Factors recorded	Tank #1: Density of cover: 60%	Tank #2: Density of cover: 51%	Tank #3: Density of cover: 41%	Tank #4 Density of cover: 19%	Tank #5 Bare soil
Rainfall (Inches)	39.19	39.19	39.19	39.19	39.19
Surface run-off (In.)	0.00	0.02	0.01	0.37	4.30
Percolation (Inches)	17.20	19.11	18.82	21.18	23.98
Total Evaporation (In.)	21.99	20.06	20.37	17.64	10.91
Erosion (Pounds)	1.98	2.11	-- [1/]	12.54	15.53

1/ No record.

7. Plans for next year — Oxford Lysimeters. The mustard sowing study to be completed. All tanks to be moved to the Gill Nursery tract during the summer of 1941.

Strawberry Canyon Lysimeters. All installations to be continued. Manipulation of vegetation by thinning to be started on oak series as soon as canopy closure is obtained. A progress report including the data through the 1939-40 season to be prepared.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Rowe, Daniel.

RI-CAL
WATER UTILIZATION
Shrub cover

January 1941

Consumptive Use of Water by Chaparral Species
North Fork

1. Field division — Forest and Range Influences.

2. Work project — Water utilization by vegetation.

3. Line project — Chaparral - consumptive use of water by chaparral species (lysimeter, soil moisture and interception studies).

4. Purpose — To study the influence of chaparral vegetation on the disposition of precipitation (surface run-off, interception, evaporation, transpiration and percolation).

5. Review of past work — Lysimeters. Four rectangular lysimeters installed in 1932, each 1000 square inches in area and 20 inches deep and filled with soil collected at site of installation. From 1932 to 1937 two tanks 13 and 15 maintained with bare soil surfaces and two tanks 12 and 14 with a 2-inch ponderosa pine litter cover. In 1937 litter cover burned off tank 14, a 2-inch ponderosa pine litter placed on tank 15, and tanks 12 and 13 continued in operation without change in treatment. In all cases the litter cover completely prevented erosion and resulted in greatly reduced surface run-off and surface evaporation and in increased percolation.

Four circular lysimeters installed in 1932, each 36 inches deep and filled with soil collected at the site of installation, - two tanks each 706 square inches and two tanks each 1000 square inches in area. All four tanks operated with bared soil surfaces until 1937. Annual evaporation losses during this period averaged from 12 to 13 inches depth. In March 1937 all tanks planted to Bromus mollis. In September 1937 vegetation on two tanks burned and these tanks have since been operated free of vegetation.

Soil moisture studies. Two 1/200-acre soil moisture sampling areas established July 1934, third area established July 1936. One area maintained with undisturbed vegetation, one burned off annually, one completely denuded. Annually burned and denuded areas trenched to isolate soil block from root penetration of surrounding vegetation. Soil moisture samples collected by 3-inch increments to 48-inch depth before and after each storm and at intervening intervals of ten days. Moisture percent and moisture equivalent determinations made for each sample. Average evaporation (interception, transpiration, and evaporation) from annually burned areas about 17.5 inches, from undisturbed area about 19 inches, and from denuded area about 12.5 inches depth per year.

Interception studies. Installation established in 1937 and now includes 16 slope rain-gages and about 30 stemflow units. Total interception averaged about 20 percent, stemflow about 15 percent, and interception loss (total interception less stemflow) about 5 percent of annual precipitation.

6. Accomplishments during past year — Lysimeters. Precipitation during 1939-40 season was 41.44 inches. From tank 12 maintained with a litter cover since establishment there was 0.6 inches surface run-off, 34.1 inches percolation, and 6.7 inches evaporation. From tank 15, with an eroded soil covered with litter for first time in 1937, there were 1.6 inches run-off, 32.9 inches percolation, and 7.0 inches evaporation. From tank 13 maintained with bared soil since establishment, there were 20.9 inches run-off, 6.5 inches percolation, and 14.0 inches evaporation. From tank 14 on which litter was burned for first time in 1937, there were 26.7 inches surface run-off, 3.8 inches percolation and 11.0 inches evaporation. Litter burned from tank 15 and tanks 14 and 15 sowed to Bromus mollis in September 1940.

On circular lysimeters there were from 5 to 6 inches more evaporation and less percolation from the grass covered than from the bare soil tanks. Had these tanks been constructed to permit free surface run-off comparable to that from undisturbed soil surface, there would have been a greater difference in surface run-off between the grass covered and denuded soils and therefore less difference in evaporation and percolation.

Soil moisture studies. Intensive soil moisture sampling discontinued in September 1940. Data partially analyzed.

Interception studies. Results of interception studies for 1939-40 season not significantly different from those of previous season. Old installations discontinued in July 1940. New interception installation to obtain data under conditions of both natural and artificial run-off started in connection with the 1/100-acre plot studies. This installation will yield data on both volumes and rates of precipitation, interception, stemflow and interception losses from a 1/100-acre plot with an undisturbed brush cover.

7. Plans for next year — All installations to be continued in operation during 1940-41 season. First 3 years results of interception-stemflow studies and results of lysimeters litter studies to be prepared for publication.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Rowe, Daniel.

RI-CAL
WATER UTILIZATION
Forests

January 1941

Consumptive Use of Water by Forest Cover
Bass Lake

1. Field division — Forest and Range Influences.

2. Work project — Water utilization by vegetation.

3. Line project — Forest cover - consumptive use of water by forest cover (second growth ponderosa pine, Bass Lake, interception and soil moisture studies.)

4. Purpose — To study the influences of second-growth ponderosa pine cover on the disposition of precipitation.

5. Review of past work — Study started during fall of 1940.

6. Accomplishments during past year — Soil moisture studies. Three 1/40-acre soil moisture sampling areas established September 1940. Vegetation on one area undisturbed, herbaceous vegetation and litter cover on one area burned off annually and third area maintained completely free of all vegetation. The denuded area trenched and enclosed with galvanized iron walls to a depth of 72 inches to isolate the soil block from root penetration of surrounding vegetation. Soil moisture sampling started on all areas in October 1940.

Interception studies. Installation established in September 1940. Includes 2 open raingages, 4 open tree gages, 20 interception gages, 10 snow pans, 32 stemflow units and a snow course.

7. Plans for next year — Soil moisture studies. Soil moisture samples to be collected from each area by 3-inch increments at intervals of 10 days and just before and immediately after each storm. Moisture percent and moisture equivalent determinations to be made of each sample collected.

Interception studies. Collection of records started in October 1940 and to be continued throughout the rainy season. Installation to be equipped to provide for the recording of intensity measurements of interception losses.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Rowe, Daniel.

RI-CAL
WATER UTILIZATION

January 1941

Consumptive Use of Water by Riparian Vegetation "Y" Canyon

1. Field division — Forest and Range Influences.

2. Work project — Water utilization by vegetation.

3. Line project — Tree species - transpiration and other consumptive uses of water by riparian vegetation in southern California.

4. Purpose — To measure losses in water yield from a mountain watershed occasioned by transpiration of riparian vegetation.

5. Review of past work — Initiated in 1931 in cooperation with U.S. Bureau of Agricultural Engineering. Four streamgaging stations constructed and detailed surveys of canyon-bottom vegetation and geology made. Development of underground leak to adjacent canyon resulted in abandoning lowest gaging stations. Paper presented at A.A.A.S. meeting in Berkeley, 1933, entitled "Vegetation of a southern California canyon." Joint progress report prepared in 1934 and summary report in 1938. Flood in March 1938, caused by 18-inch rain, completely cleared "A" fork of the "Y" and main channel below forks of all streambottom vegetation. "B" branch of "Y" comparatively unaltered. Weir reinstalled at mouth of "A" fork and in lower main channel to compare bare and vegetated streambottom. One climatic station installed in clear area of main channel and one under cover in "B" fork. Records collected during summer months. Instruments removed before storm flows start. Records since first report partially analyzed.

6. Accomplishments during past year — Instruments were installed and data collected during summer months were tabulated. Instruments removed for winter season.

7. Plans for next year — Reinstall instruments and collect records for summer period if personnel is available. If not, measurements will be discontinued for two or three years then resumed for a like period, etc., to obtain at least intermittent data during regrowth of riparian trees. Continue compilation and summarization of data.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Sinclair, Storey, Weaver.

RI-CAL
WATER UTILIZATION

January 1941

Influence of Various Physiographic, Climatic, and Biotic Factors on Infiltration

1. Field division — Forest and Range Influences.

2. Work project — Water utilization - by vegetation - (infiltration capacity measurements).

3. Line project — Infiltration. Influence of various physiographic, climatic, and biotic factors on infiltration.

4. Purpose — To develop methods for the analysis and interpretation of infiltration data and to further test and perfect the North Fork infiltrometer and other infiltration equipment.

To determine the influence of such factors as slope, soil type, vegetation, land use, and intensity and duration of rainfall on the infiltration capacity of soils.

5. Review of past work — Instrumentation, operating procedures, and methods for the analysis and interpretation of infiltration data developed and tested under field conditions. These have been reported in the publication, "The construction, operation, and use of the North Fork infiltrometer," California Forest and Range Experiment Station Miscellaneous Publication No. 1. An infiltration study, comprising approximately 130 runs, made in cooperation with the Bureau of Reclamation on a 100-acre watershed near Friant, California, completed in 1939, and data now being prepared for publication.

6. Accomplishments during past year — Infiltration sampling conducted in connection with Pajaro Flood Control Survey, in which Station members acted as technical consultants and assisted in the interpretation and analysis of the data, completed. Results indicated tremendous differences in infiltration capacities for the different vegetation and soil types sampled. The grass (grazing areas) and cultivated areas in general had much lower infiltration capacities than brush and forest-covered areas. Results were also of value in determining influences of such factors as land use, degree of use, soil type, slope, exposure, organic matter, soil moisture, and density of cover on infiltration and surface run-off.

An infiltration study, employing the North Fork infiltrometer to determine the influence of different intensities of grazing on the infiltration capacity of the soil was made on the 1/40-acre surface run-off and erosion plots of the San Joaquin Experimental Range in cooperation with the Division of Grazing. Fifty-four determinations were made on nine plots with the following results:

Number of plots	Experimental treatment	Soil at summer dryness: No. of tests	Soil at summer dryness: Infiltration capacity (In. per hr.)	Soil moisture at field capacity: No. of tests	Soil moisture at field capacity: Infiltration capacity (In. per hr.)
3	Ungrazed 5 years	9	8.3	9	8.0
3	Ungrazed 3 years Moderately grazed 2 years	9	6.6	9	5.8
3	Ungrazed 3 years Heavily grazed 2 years	9	4.5	9	3.4

These data indicate sharply the influence of moderate or heavy grazing on infiltration capacities of soils sampled. Difference in mean infiltration capacities between treatments were statistically significant and differences between mean infiltration capacities of ungrazed and heavily grazed plots were highly significant. When soils were air dry, mean infiltration capacities average from 0.3 to 1.1 inches higher than when soil moisture contents were at field capacity.

This plot experimentation is intended to explore the mechanics of the water cycle and not for quantitative extension to large watersheds. However, above findings were corroborated by the fact that natural rains on plots produced no surface run-off.

Infiltration sampling on the Santa Maria Flood Control Survey project was started in November 1940. The North Fork and the new F and FA types of infiltrometers are being employed to develop converting factors in order to permit use of results obtained by different methods on a common basis. An infiltration survey of the Big Creek experimental watersheds has also been undertaken with assistance of Kings River WPA project.

7. Plans for next year — Infiltration studies now in progress to be continued and the results of completed studies to be prepared for publication. Additional infiltration studies to be undertaken as time and facilities permit.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Rowe, and other members of the Influences staff.

Relation of Forest, Brush, and Grassland Cover and Management Practices to Erosion and Soil Stability State-wide

1. Field division — Forest and Range Influences.

2. Work project — Stabilization of soils.

3. Line project — Watersheds - relation of forest, brush, and grassland cover and management practices to erosion and soil stability and to quality and usability of water (intensive-measurement erosion surveys).

4. Purpose — To determine amount of erosion from mountain areas in relation to precipitation, vegetation, geology, soil, and other contributing factors by surveys of sedimentation in reservoirs commanding large and small watersheds and by detailed measurements from plots.

5. Review of past work — Measurements of erosion from drainage units started in 1927 at Barranca watershed (Devil Canyon Branch) and have since been extended to Lost Creek Reservoir (Plumas National Forest); Bell, Fern, San Dimas, and Big Dalton watersheds (San Dimas Experimental Forest); and Big Creek watersheds (Kings River Branch).

Other reservoirs including Morena and Little Rock Creek in southern California have been surveyed by the Soil Conservation Service under a cooperative agreement with the Forest Service, whereby they make the sedimentation surveys and the Forest Service studies erosion in the watersheds, the data being combined in joint reports. The first report, "Effect of accelerated erosion on silting in Morena Reservoir, San Diego County, Calif.," U.S.D.A. Tech. Bul. No. 639 by F. F. Barnes, C. J. Kraebel, and R. S. LaMotte was published in December 1939.

Erosion measurements from plots were started in southern California during 1927 and subsequently at other locations as described under "Relation of chaparral cover to streamflow - plot studies." Erosion plot studies have also been made on certain burned areas in southern California and in the Kennett area in the northern part of State.

Soil losses from Barranca watersheds as measured in the reservoir for a 10-year period from 1927-37 totaled 1500 cubic yards or 21,700 cubic yards per square mile. Continued severe erosion indicates prolonged effect of denudation by fire.

Summary of erosion rates under different vegetative conditions

Watershed	Age of vegetation	Rate of erosion cu.yds./sq.mi.
Storm of March 1938 (19 to 23 inches)		
Bell small watersheds	19 years	20,000
Fern small watersheds	over 50 years	2,000 to 5,000
Storm of December 1938 (12 inches)		
Bell small watersheds	19 years	Trace
Fern small watersheds	denuded Nov. 1938	5,000

Erosion from both Fern and Bell watersheds during storm of March 1938 was largely result of stream channel scouring, whereas that from the Fern watershed during the December storm was mostly a result of soil movement from the slopes.

Average annual deposition in San Dimas Reservoir from 1923 to 1937 was at rate of 1100 cubic yards per square mile of watershed, in Big Dalton Reservoir annual rate from 1928 to 1937 was 4400 cubic yards per square mile.

Rate of erosion from the Big Creek watersheds (Kings River) was approximately 160 cubic yards per square mile for the 1936-37 season, 10,000 to more than 20,000 yards for 1937-38, and 150 cubic yards for 1938-39.

6. Accomplishments during past year — All surveys made as planned for this project. Erosion rates were low for season due to moderate precipitation. For example, rates of erosion for the season 1938-39 as measured by deposition in reservoirs ranged from only a trace from the three small Bell watersheds to an average of nearly 9,000 cubic yards per square mile from the three small Fern watersheds, whereas, during the 1939-40 season there was no erosion from Bell watersheds and an average of less than 200 cubic yards per square mile from Fern watersheds.

Watershed improvement plan for Big Dalton drainage above flood control reservoir prepared in cooperation with Flood Control Surveys and WPA project application completed for work. Measures proposed include slide and road slope fixation, improved road drainage and stabilization of stream channels with masonry barriers.

7. Plans for next year — Detailed surveys of the silt deposits in the San Dimas and Big Dalton Reservoirs will be made if seasonal deposition is significant. Erosion records from all plots will be continued.

8. Date of completion — No definite date has been set for the completion of the reservoir survey or plot projects. However, the cooperative work with the Soil Conservation Service should be completed within the next five years.

9. Assignment — Kraebel, Sinclair, Rowe, Hamilton, Storey.

RI-CAL
SOIL STABILIZATION
Watersheds

January 1941

Revegetation for Watershed Improvement

1. Field division — Forest and Range Influences.

2. Work project — Stabilization of soils.

3. Line project — Watersheds - propagation and testing of plants for watershed improvement.

4. Purpose — Development of satisfactory planting practices for California with emphasis on the optimum methods of obtaining cleaned seed, germinating, propagating, and growing chaparral, broadleaf and coniferous species and their evaluation for erosion control on burned areas, road slopes, slides and other sites needing cover improvement.

5. Review of past work — Seed handling. Project initiated in 1931 and expanded in 1934. Successful germination has been obtained with approximately 700 species of native California plants, of which more than 100 had heretofore failed to reproduce by seed.

Research Note No. 18, "Collecting and propagating the seeds of California wild plants" by N. T. Mirov and C. J. Kraebel, published in 1937, presents methods of cleaning, storing, and germinating the seeds of 255 native species. Increased knowledge has been gained in methods of seed storage and its influence on germination.

Nursery practice and propagation. Two experimental plant nurseries have been established. The first at Devil Canyon on the San Bernardino National Forest in 1927 with financial aid from several southern counties, the second at Berkeley in 1936, in cooperation with the University of California and the Regional Office.

The Devil Canyon nursery has an average annual production of 35,000 seedlings of which 30,000 are distributed to southern counties and forests for erosion control and improvement planting. The Berkeley nursery has distributed a total of over 35,000 plants to national forests for similar use.

Research projects at both nurseries include vegetative propagation and studies of germination, root development, potting methods, field nursery practice and production technique.

Planting and sowing.

Methods. Approximately 35,000 trees have been set out to test methods of planting in burns and other areas of depleted forest cover along roadsides and on slope fixation projects, while additional plantations have been made to test the adaptability of species.

Firebreaks. Six plots were established on the San Dimas Experimental Forest at elevations ranging from 1500 to 5000 feet to test the effectiveness of eight succulent species for fire-resistant ground cover planting on firebreaks. Additional extensive plots were established on Los Padres National Forest.

Results of tests indicate that the following three species may prove satisfactory for firebreak planting: Mesembryanthemum croceum, M. edule and Atriplex semibaccata.

Burned areas. Supervision and cooperation in the sowing of mustard (Brassica nigra) for erosion control on more than 50,000 acres of burned watersheds in southern California, by the Forest Service and other forest agencies.

6. Accomplishments during past year — Nursery practice and propagation. Successful propagation of erosion control plants heretofore considered impossible by commercial nurseryman.

Distribution of 50,000 plants from the Berkeley nursery and 36,000 plants from the Devil Canyon nursery for erosion control and improvement planting by national forests and other agencies.

Revision of Research Note No. 18 was published in 1939 as CCC Forestry Publication No. 5, "Collecting and handling the seeds of wild plants", by N. T. Mirov and C. J. Kraebel.

Planting and sowing.

Methods. Continued planting and made complete examination of existing plantations in vicinity of Devil Canyon nursery. Planting records compiled and partially analyzed.

Burned areas. Surveys continued on Fern watershed No. 1, burned November 1938, and sown to mustard (Brassica nigra) to determine effectiveness of cover, area of original stand, relation of climate to subsequent year's crops, and effect of the mustard cover on natural succession.

7. Plans for next year — Seed handling. Continue research in methods including initiation of more exact germination techniques if personnel is available.

Nursery practice and propagation. Continue propagation of erosion control plants for experimental use with emphasis upon native shrubs for southern California flood control program. Additional research projects for weed control, watering practices, nursery technique, methods of propagation and root studies. Revision and enlargement of Station Research Note on propagation of native plants.

Planting and Sowing. Continue field trials of methods and species. Complete examination and analysis of past work for possible publication. Survey of planting requirements in southern California for watershed improvement. Continue tests of the effectiveness of mustard in erosion control and studies of the phenology and succession of the mustard in Fern watershed No. 1.

8. Date of completion — For project as whole: intensive investigation to be completed in next five years. Routine examinations and observations to continue beyond this period.

9. Assignment — Kraebel, Sinclair, Weaver.

RI-CAL
SOIL STABILIZATION
Road banks

January 1941

Development of Methods and Stabilizing of Earth Fills and Cuts Mountain Roads

1. Field division — Forest and Range Influences.

2. Work project — Stabilization of soils.

3. Line project — Roads - development of practicable and inexpensive methods of permanently stabilizing unconsolidated earth fills and cuts, particularly in connection with mountain road construction.

4. Purpose — Development of economic methods of preventing or controlling destructive erosion on mountain roads by improved drainage practices, slope fixation and planting.

5. Review of past work — Tests of seven slope fixation treatments have been made on roads of central and southern California. Most satisfactory method devised, considering effectiveness and economy, is contour wattling, in rows staked with Baccharis cuttings and inert material, spaced 3 to 4 feet apart on slope. Some sites require mulching with hay. This treatment has proved effective in stabilizing slopes preparatory to permanent control by planting. U.S.D.A. Circular 380, "Erosion Control on mountain roads," published in March 1936. Unpublished manuscript on "Analysis of methods of road slope stabilization." Partial survey of roads and compilation of erosion measurements were accomplished as a part of the Flood Control Surveys in southern California.

   Drainage improved, dips installed, 3 culverts and 30 masonry toe walls constructed on approximately 3 miles of mountain road within area burned November 1938, on San Dimas Experimental Forest.

6. Accomplishments during past year — Thirteen hundred shrubs representing 28 species were planted at various elevations to test their adaptability for erosion control purposes. Erosion control measures were applied to 3 miles of road slopes within the San Dimas Experimental Forest.

7. Plans for next year — Continue planting of chaparral shrubs on road slopes for adaptability tests. Examination of existing plantings to determine survival percentages. Detailed observations planned to determine effectiveness of improved drainage and slope stabilization measures on San Dimas Experimental Forest roads.

8. Date of completion — Indefinite.

9. Assignment — Kraebel, Sinclair.

RI-CAL
SOIL STABILIZATION
Watersheds

January 1941

Erosion Control - Mountain Meadows

1. Field division — Forest and Range Influences.

2. Work project — Stabilization of soils.

3. Line project — Watersheds - erosion control - mountain meadows.

4. Purpose — To coordinate and develop planting and engineering methods of controlling gullies in mountain meadows.

5. Review of past work — In cooperation with the Regional Office of Range Management, the Experiment Station attacked the problem by training men in the control methods and by planting and giving technical direction to meadow erosion control work on 12 national forests in the Region. A mimeographed handbook, "Erosion control in mountain meadows" by C. J. Kraebel and A. F. Pillsbury was issued in 1934. Brief field examinations were made in 1938 of portions of past work on Plumas and Tahoe National Forests.

6. Accomplishments during past year — Work on this project temporarily suspended for lack of personnel but is being carried forward in part in connection with Flood Control Surveys. It was given some impetus also in connection with the revision of the regional handbook of Range Management. The Division cooperated with local citizens and Regional and local forest officers in a study of erosion problems in the Crestline and Arrowhead areas of the San Bernardino National Forest (Zone 5 of the San Bernardino County Flood Control District), the results being presented in a report by N. F. Meadowcroft of the Regional Office.

7. Plans for next year — Limited field examinations of past work are proposed to check the effectiveness of the methods employed. The handbook requires revision but this can only be done during the coming year if additional personnel becomes available.

8. Date of completion — This project should be completed within the next three to four years.

9. Assignment — Kraebel.

RI-CAL
CLIMATE
Shrub cover

January 1941

Effect of Chaparral and Grass Covers on Local Climate

1. Field division — Forest and Range Influences.

2. Work project — Effect of cover on climate.

3. Line project — Low vegetation: effect of chaparral and grass covers on local climate.

4. Purpose — To study micro-climate of the different vegetation types of the chaparral region as influenced by vegetation, geographic location, topography, altitude, and soil.

5. Review of past work — Climatic studies were initiated in 1926 with the beginning of forest influences work in the Region. They include all precipitation, air and soil temperature, relative humidity, air movement, and evaporation studies conducted at the field stations within the chaparral region, and are collected primarily for use in conjunction with other forest influences data. A list of the principal work centers and the observations now recorded at each are given in the following table:

Work center	Climatic factors observed and number of installations							
	Record started	Precipitation	Air temp.	Humidity	Evaporation	Air movement	Soil temp.	Complete climatic station
	Year							
Devil Canyon	1926	10	1	1	1	1	2	1
North Fork	1929	10	1	1	1	1	2	1
Berkeley (Strawberry Canyon and Oxford)	1931	12	3	2	4	3	-	3
San Dimas Exp. Forest	1932	340	7	7	6	6	8	4
Kings River (Big Creek)	1935	103	3	3	1	4	1	-

In addition to above, precipitation, temperature, and humidity records have been collected in connection with many of the smaller influences studies throughout the chaparral type. Most intensive studies of climate are those on the San Dimas Experimental Forest, where 4 completely equipped weather stations have been established to study the micro-climate within the experimental watersheds.

6. Accomplishments during past year — Devil Canyon, North Fork, Berkeley (Strawberry Canyon and Oxford St.), and Kings River (Big Creek) installations maintained and data tabulated as collected. Several new instruments installed at Kings River and Berkeley, including a pyroheliometer at the latter station.

San Dimas. Following 1938-burn in Fern Canyon, comparative soil and air temperature observations initiated in both burned and unburned areas. Comparative evaporation measurements in burned and unburned areas made for same period using Bates evaporimeters. Data summarized but no analysis made yet. Both studies discontinued at start of 1940-41 season due to partial revegetation of burn. Rain gage comparative study indicates that a gage with funnel tilted parallel to slope and set at ground level gives most satisfactory results if protected from splash by screen or litter on ground for 3-foot radius.

7. Plans for next year — The Devil Canyon, North Fork, Berkeley, and Kings River installations now in operation will be continued. Results of the North Fork soil temperature studies to be prepared for publication.

San Dimas. Operation of buried evaporation pans will be discontinued. Bates evaporimeters will be substituted for Weather Bureau pans at remote stations. Wind direction and velocity recorders will be discontinued at Fern, Bell No. 4, and San Dimas Canyon climatic stations. Wind velocity at Sunset Peak and Fern will be recorded by remote control at San Gabriel Divide climatic station. Wind direction and velocity equipment will be moved from San Dimas Canyon climatic station to Johnstone Peak Fire Lookout in order to get record of front country free air movement and tie in with forest protection.

8. Date of completion — Indefinite.

9. Assignment — Kraebel and Forest Influences staff as a whole.

RI-CAL
CLIMATE
Forest Cover

January 1941

Effect of Forest Cover on Local Climate

1. Field division — Forest and Range Influences.

2. Work project — Effect of cover on climate.

3. Line project — Forest - effect of forest cover on local climate.

4. Purpose — To study micro-climate of the different forest types of the pine region as influenced by vegetation, geographic location, topography, altitude, and soil.

5. Review of past work — Bass Lake (second growth ponderosa pine) Climatic studies initiated in 1934. Installations now include: 1 standard weather shelter equipped with maximum and minimum air temperature thermometers, 1 psychrometer, 1 hygrothermograph; 1 intensity, 3 standard and 4 tree crown rain gages; 2 anemometers; 4 snow-melting stations, 42 snow depth stakes and a 400-foot snow course.

Kings River-Teakettle Creek (old growth, mixed conifer, sugar pine-fir type) Climatic studies started in 1938. Installations now include: 1 standard weather shelter equipped with maximum and minimum air temperature thermometers, 1 psychrometer, 1 hygrothermograph and 1 anemometer; 1 combination snow-soil thermograph installation with 3 snow and 4 soil recordings at varying depths; and 15 snow courses, each approximately 200 feet long.

6. Accomplishments during past year — Climatic stations were maintained and enlarged during the year and data tabulated as collected.

7. Plans for next year — Installations now in operation will be continued during 1941-1942.

8. Date of completion — Indefinite.

9. Assignment — Kraebel and Forest Influences staff as a whole.

RIFC-CAL
WATERSHEDS
Preliminary examination

January 1941

Preliminary Examinations
(An Interbureau Cooperative Project)

1. Field division — Flood Control Surveys.

2. Work project — Flood control surveys.

3. Line project — Preliminary examinations.

4. Purpose — To examine and evaluate watershed conditions that contribute to floods and accelerated erosion and their economic effect on the basin as a whole with a view to determining the need for a detailed flood control survey.

5. Review of past work — Work initiated during 1937 in accordance with Flood Control Act, and in cooperation with two other bureaus of the Department, namely, Soil Conservation Service and the Bureau of Agricultural Economics.

Preliminary reports on the Kings River, Kaweah-Tule Rivers, Merced Group, Kern River, Pajaro River, Salinas River, Santa Maria River, Upper Sacramento River, Ventura River and Madera-Fresno-Upper San Joaquin Group were submitted to Washington prior to 1940; 32 public hearings held for 32 streams or groups of streams.

6. Accomplishments during past year — Preliminary examination reports were completed and forwarded to Washington on the Santa Ynez River and the Walker River watersheds.

7. Plans for next year — Continue preliminary field surveys as authorized and prepare reports in cooperation with other bureaus of the Department.

8. Date of completion — Fiscal year 1942.

9. Assignment — Field Coordinating Committees 18 & 20:
Kotok (FS), Reddick (SCS), Co-chairmen;
Selby (BAE).
Lawrence (FS), Executive Secretary.
Field Work Committee:
Kraebel (FS), Chairman; Johnston (SCS),
Hill (BAE).
Fittinger (FS), Fox (SCS), Keene (BAE).

(In addition during part of this year, Munson, Gleason and Woodruff were assigned.)

RIFC-CAL
WATERSHEDS
Survey

January 1941

Watershed Surveys
(An Interbureau Cooperative Project)

1. Field division — Flood Control Surveys.

2. Work project — Flood control surveys.

3. Line project — Watershed surveys (detailed surveys).

4. Purpose — To determine flood and erosion source areas and to develop economically feasible measures for the control of erosion and the retardation of run-off.

5. Review of past work — Under authority of the Flood Control Act of June 22, 1936, and subsequent Acts of 1938 and 1939, the Department of Agriculture began detailed surveys on the following California watersheds: Los Angeles, 1938; San Gabriel, 1939; Pajaro, 1940; Santa Ana, 1940; and Santa Maria, 1940. The Forest Service, Soil Conservation Service, and Bureau of Agricultural Economics cooperate in the field survey and preparation of reports for these watersheds. The survey report for the Los Angeles River watershed was completed in October 1939, and submitted to the Washington Coordinating Committee for review and approval.

Survey work outlines were completed and approved for the Kings, Kaweah-Tule, Kern River Group and the Pajaro River.

6. Accomplishments during past year — Survey report on the Los Angeles River watershed was revised and an operations program authorized for the Arroyo Seco watershed and the San Fernando valley, tributaries to the Los Angeles River. Survey report on the San Gabriel River watershed was completed by the field party and submitted to the Field Working Committee for review. Survey work plans for the Santa Ana and Santa Maria Surveys were completed and survey work initiated in September and November, respectively. Status of active surveys is as follows: Pajaro - 85 percent complete; Santa Ana - 25 percent; Santa Maria - 20 percent.

Two temporary stream gaging stations and eight rain gages were established on two case study areas in the Santa Maria River watershed to obtain current season records. A total of 150 infiltrometer runs was made on five land use classes during November and December, using "F", "FA" and North Fork infiltrometers.

Survey Work Outlines were authorized and prepared on the Santa Ana, Santa Maria, and Salinas Rivers.

7. Plans for next year — Completion of field work and survey reports for the Pajaro, Santa Ana, and Santa Maria Surveys. Completion of San Gabriel Report and Salinas Survey Work Outline. Initiation of such Surveys and Survey Work Outlines as may be approved for Fiscal Year 1942. Salinas River and Kings, Kaweah-Tule, Kern River Group recommended for Survey and report under chairmanship of Soil Conservation Service and Forest Service, respectively.

8. Date of completion — Pajaro River Report, March 31. Santa Maria and Santa Ana River Reports, June 30. Salinas Survey Work Outline, February 28.

9. Assignment

Field Coordinating Committees 18 & 20
Kotok (FS), Reddick (SCS), Co-chairmen;
Selby (BAE)
Lawrence (FS) Executive Secretary
Field Work Committee:
Kraebel (FS) chairman; Johnston (SCS),
Hill (BAE).
Pajaro Survey:
Gabbert - Project Leader until Sept. 1940
Gannon (SCS) Acting Project Leader
Kolbe (FS) Senior Representative
Landstrom (BAE) Senior Representative
San Gabriel Survey:
Ilch - Project Leader
Tanner (FS) Senior Representative
Barrett (SCS) Senior Representative
King (BAE) Senior Representative
Santa Maria Survey:
Ilch (FS) Project Leader
Kolbe (FS) Senior Representative
Gannon (SCS) Senior Representative
Landstrom (BAE) Senior Representative
Santa Ana Survey:
Gabbert (SCS) Project Leader
Gleason (FS) Senior Representative
Barrett (SCS) Senior Representative
Woodruff (BAE) Senior Representative
Survey Work Outlines
Lawrence (FS, Region 5), Chairman
Committee composed of Fittinger (FS),
Fox (SCS) and Keene (BAE)